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Final Report

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EVALUATION OF MOTOR VEHICLE EMISSIONS INSPECTION AND MAINTENANCE PROGRAMS IN WISCONSIN

PHASE 3

Final Report

November 1978

by

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ABSTRACT

Recent data for the State of Wisconsin indicates that the National Ambient Air Quality Standards for CO and O_x will not be attained in all areas of the state by 1982, even if all reasonably available control technologies are applied. In view of this, it is likely that the state will request from U.S. EPA an extension of the compliance data beyond 1982. In order for this request to be considered, the state must, among other things, have adopted a firm schedule for implementing a motor vehicle inspection and maintenance (I/M) program in the highly urbanized nonattainment areas. In this connection, the State of Wisconsin is currently planning for the implementation of an I/M program. As part of this effort, detailed analyses have been performed of the costs, benefits, personnel requirements, direct and indirect impacts, and scheduling requirements associated with the particular program option being considered. This document reports these analyses.

CONTENTS

Abstract iii
List of Figures vii
List of Tables viii
Acknowledgments xiii

1. Introduction 1
    Background and Objective 1
    Basis and Organization of this Report 3
    References 5
2. Program Option 6
    Option Definition 6
    Emissions Inspection Scenario 8
3. I/M Program Benefits and Impacts 12
    Introduction 12
    Emissions Reductions 12
    References 31
4. Network and Personnel Requirements 32
    I/M Network 32
    Personnel Requirements 35
5. Adjunctive Programs 43
    Introduction 43
    Consumer Protection 44
    Warranty Protection 49
    Public Convenience 52
    Public Relations Program 53
    Quality Assurance 55
    Mechanics Training 57
    Program Enforcement Considerations 60
6. Legislative Considerations 63
    Introduction 63
    Approach and Methodology 63
    Legislative Issues 63
7. Cost Analysis 89
    Methodology 89
    Fee Computation 116
8. Implementation Planning 125
    Introduction 125
    Immediate Issues 126
9. Summary and Conclusions 139
    Background of This Study 141
    Option Definition 145
    Emissions Inspection Scenario 146

CONTENTS (continued)

I/M Program Network 147
Program Administration and Personnel Requirements 149
I/M Program Benefits 149
I/M Program Costs 158
Adjunctive Programs 158
Conclusions 162
References 165

Appendices

A. General Methodology 166
  General Methodology 166
  Option Costs 166
  Fee Computation 180
  Emissions 188
B. Detailed Description of Methodology for Calculating Emission Inventories 190
  References 197
C. Estimated Fuel Savings in 1987 Resulting From I/M 198
  Fuel Savings 198
  Summary Figures 207
D. Introduction 211
  Problems Associated With Winter Emissions Testing 211
  Mitigating Measures 213
  References 214

FIGURES

No. Page

1 Motor vehicle inspection and registration flow chart 11

2 Daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M in nine Wisconsin counties - 1982 through 1987 18

3 Daily HC emissions by year for LDV's and LDT's, and all vehicles, with and without I/M in nine Wisconsin counties - 1982 through 1987 19

4 Daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M in the Seven County Greater Milwaukee area - 1982 through 1987 20

5 Daily HC emissions by year for LDV's and LDT's, and all vehicles with and without I/M in the Seven County Greater Milwaukee area - 1982 through 1987 21

6 Effect of varying the stringency level on CO emissions for LDV's and LDT's, and all vehicles for 1983 and 1987 24

7 Effect of varying the stringency level on HC emissions for LDV's and LDT's, and all vehicles for 1983 and 1987 25

8 Suggested administrative structure for the state-run option 39

9 Suggested administrative structure for the contractor-run option . . . 40

10 Conceptual floor plan for a combined safety, noise, and loaded-mode emission inspection facility 92

11 Suggested administrative structure for the state-run option 151

12 Suggested administrative structure for the contractor-run option . . . 152

13 Daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M - 1982 through 1987 155

14 Daily HC emissions by year for LDV's and LDT's, and all vehicles with and without I/M - 1982 through 1987 156

TABLES

No.

1 Projected Carbon Monoxide Emissions (kg/day) and Percent Reductions Achievable for LDV's and LDT's Only 14

2 Projected Hydrocarbon Emissions (kg/day) and Percent Reductions Achievable for LDV's and LDT's Only 15

3 Projected Carbon Monoxide Emissions (kg/day) and Percent Reductions Achievable for all Vehicles 16

4 Projected Hydrocarbon Emissions (kg/day) and Percent Reductions Achievable for all Vehicles 17

5 Effect of Varying the Stringency Factor on CO and HC Emissions Reduction Potential 23

6 Annual Growth Rate, Inspectable Vehicle Population, 1973 to 1978 . . 33

7 1987 Inspectable Vehicle Population, Using Two Different Projection Methods 33

8 Inspections Required, 1987 34

9 Inspection Lanes Required, 1987 35

10 Inspection Network 36

10a Inspections Required 1982 to 1987 36

11 Operating Personnel Requirements 38

12 Administrative Personnel Requirements for State-Run and Contractor-Run Options 42

13 I/M Repair Costs 48

14 General Specifications of a Typical I/M Centralized Facility Emission Analyzer 58

15 Sample Cutpoints Defined as a Function of Model Year For the Idle Mode Test 67

TABLES (continued)

No.

16 Outline of Program Cost Categories and Elements 90

17 Floor Area Requirements for Various Facility Configurations - Emissions Testing With Capability to Expand to Include Safety and Noise Testing 93

18 Inspection Network Requirements 93

19 Building Cost Estimates 94

20 Estimated Land Values for Commercially-Zoned Land in Nine Selected Wisconsin Counties 94

21 Estimated Land Investment Requirements by County 96

22 Major Equipment Items Required for Loaded-Mode Emissions Testing . . 97

23 Equipment Costs as a Function of Facility Configuration 98

24 Equipment Costs for Loaded Mode Testing Network 99

25 Initial Capital Cost Summary 100

26 Estimated Hourly Starting Salaries for Administrative and Operational Personnel Involved in Inspection and Maintenance Programs in Wisconsin 104

27 Administrative Personnel Costs Associated With Program Startup, State-Run Option 106

28 Administrative Personnel Costs Associated With Program Startup, Contractor-Run Option 107

29 Summary of Startup Costs 108

30 Annual Personnel Costs for Facility Personnel 109

31 Annual Calibration Costs 111

32 Annual Taxes - Contractor-Run Option 112

33 Annual Cost for Utilities, Services, and Supplies - State Versus Contractor-Run Options 113

34 Annual Administrative Personnel Costs - State-Run Option 114

35 Additional Administrative Personnel Costs for Contractor Option . . . 115

TABLES (continued)

No.

36 Cost Summary - State-Run Option 117

37 Cost Summary - Contractor-Run Option 118

38 Annualized Costs for the State-Run Option in Constant Dollars 120

39 Annualized Costs for the Contractor-Run Option in Constant Dollars 120

40 Annualized Costs for the State-Run Option in Actual Dollars 121

41 Annualized Costs for the Contractor-Run Option in Actual Dollars. . . 121

42 Break-Even Fees, f_c, in Real 1978 Dollars, and f_a in Actual Dollars for the State-Run and Contractor-Run Options 122

43 Cost Schedule for a State-Run Program, 1979-1987 123

44 Cost Schedule for a Contractor-Run Program, 1979-1987 124

45 Implementation Schedule - Summary 137

46 I/M Options Analyzed 142

47 Breakeven Fees in Constant 1978 Dollars for Options 1 Through 6 . . . 143

48 1987 Inspectable Vehicle Population, Using Two Different Projection Methods 148

49 Inspections Required 1982 to 1987 148

50 Inspection Network 150

51 Program Employees 150

52 Projected Percent Reductions in CO and HC Emissions 1983 to 1987 Due to I/M 154

53 Outline of Program Cost Categories and Elements 159

54 Cost Summary - State-Run Option 160

55 Cost Summary - Contractor-Run Option 161

56 Breakeven Fees, f_c, in Real 1978 Dollars, and f_a, in Actual Dollars for the State-Run and Contractor-Run Options 158

TABLES (continued)

No.

57 Implementation Schedule - Summary 163

A-1 Inspection Network Requirements 167

A-2 Building Cost Estimates, Seven County Option 167

A-3 Estimated Land Investment Requirements by County, Seven County Option 168

A-4 Equipment Costs for Loaded Mode Testing, Seven County Option 169

A-5 Initial Capital Cost Summary, Seven County Option 170

A-6 Administrative Personnel Costs Associated With Program Startup, State-Run Option 173

A-7 Administrative Personnel Costs Associated With Program Startup, Contractor-Run Option 174

A-8 Summary of Startup Costs, Seven County Alternative 175

A-9 Annual Personnel Costs for Facility Personnel 176

A-10 Annual Taxes - Contractor-Run Options 178

A-11 Annual Costs for Utilities, Services, and Supplies - State Versus Contractor-Run Options, Seven County Alternative 179

A-12 Cost Summary - State-Run Options 181

A-13 Cost Summary - Contractor-Run Option 182

A-14 Annualized Costs in Constant 1978 Dollars 183

A-15 Annualized Costs in Actual (Inflated) Dollars 184

A-16 Breakeven Fees, f_c in Constant 1978 Dollars, and Fee in Actual Dollars for the State-Run and Contractor-Run Options; Seven County Alternative 185

A-17 Cost Schedule for a State-Run Program, 1979 Through 1987 186

A-18 Cost Schedule for a Contractor-Run Program, 1979 Through 1987 187

A-19 Effect of Varying Stringency Factor on CO and HC Emissions - Presented as Percent Emissions Reduction as a Function of Stringency Factor 188

TABLES (continued)

No.

A-20 Effect of Varying the Vehicle Age Exemption on Emissions Reductions for 1987 189

B-1 Travel Weighting Factor Calculation Light-Duty Vehicles 191

B-2 Daily VMT for Brown and Dane Counties 193

B-3 Daily VMT and Average Speed 194

B-4 Wisconsin VMT 1977 195

B-5 Wisconsin VMT 1987 196

C-1 Estimated Daily LDV VMT Figures for Selected Counties for 1987 . . . 199

C-2 Travel Weighting Factor Calculation for Light-Duty Vehicles 200

C-3 EPA MPG Specifications and Average Fleet Mileage for LDVs Covered by I/M in 1987 201

C-4 Potential Annual LDV Fuel Savings in 1987 Due to I/M (In Gallons) 202

C-5 Estimated Daily LDV VMT Figures for Selected Counties for 1987 . . . 203

C-6 Travel Weighting Factor Calculation Light-Duty Gas Trucks <6000 lb (LDT 1) 204

C-7 Mileage Estimates and Average Fleet Mileage for LDT 1 Covered by I/M in 1987 205

C-8 Potential Annual LDT 1 Fuel Savings in 1987 Due to I/M (In Gallons) 206

C-9 Travel Weighting Factor Calculation Light-Duty Gas Trucks 6001 to 8500 lb (LDT 2) 208

C-10 Mileage Estimates and Average Fleet Mileage for LDT2 Covered by I/M in 1987 209

C-11 Potential Annual LDT2 Fuel Savings Due to I/M in 1987, in Gallons . . 210

C-12 Potential Annual Fuel Savings Due to I/M in 1987, in Gallons 210

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SECTION 1

INTRODUCTION

BACKGROUND AND OBJECTIVE

Amendments to the Clean Air Act that were adopted during 1977 have established that the National Ambient Air Quality Standards (NAAQS) for pollutants such as carbon monoxide (CO) and photochemical oxidents (O_x) must be attained in all areas of the U.S. no later than 31 December 1982. The U.S. Environmental Protection Agency, the federal agency charged with the responsibility of administering and enforcing the Clean Air Act and ammendments thereto, has set the requirement that each state containing an area (or areas) currently in violation of the NAAQS must submit a revision to its State Implementation Plan (SIP) during January 1979 demonstrating compliance in all areas by 31 December 1982. That all states will not be able to demonstrate total compliance by the end of 1982 is recognized in the Amendments and provisions are made for extending the compliance date to 31 December 1987. In order to obtain the extension, however, the revised SIP to be submitted in January 1979 must include (among other things) a specific schedule for the implementation of a motor vehicle emissions inspection and maintenance (I/M) program in those nonattainment areas that have an urbanized population greater than 200,000. Failure to submit an acceptable I/M schedule (or if a reasonable effort toward submitting an acceptable schedule is not being made) will result in rather severe sanctions being imposed on the state.

Preliminary reviews of the status of air quality control regions in the State of Wisconsin have indicated that the NAAQS for O_x and/or CO will likely not be achieved by 31 December 1982 in all instances. Given the requirements of the Clean Air Act Amendments mentioned above, a decision was made to initiate action that would serve to identify the overall requirements for I/M in the State. This action involved the establishment of an Inter-Agency Task Force, comprised of representatives from the Departments of Natural Resources and Transportation, which will provide a technical advisory function for the State. Also, to assist the State in its early efforts, the Region V Office of the U.S. Environmental Protection Agency contracted a consulting firm - GCA/Technology Division - to provide specific technical assistance to the Inter-Agency Task Force.

The initial effort in this connection was the development of background data regarding the general technical and administrative aspects of I/M programs, and a summary of various states' experiences to date with actual program operation. GCA provided this background information through a series of technical memoranda[1,2,3] and a summary report.[4]

Based in part on the data provided by GCA, the Inter-Agency Task Force identified and evaluated a series of 55 possible I/M program options. As a result of the evaluation, the Task Force selected a total of six specific I/M program options that appeared to be the most appropriate for implementation in Wisconsin. These included (1) centralized, contractor-operated, steady-state, loaded mode emission testing combined with noise and safety inspections; (2) centralized, contractor-operated, loaded-mode emission testing; (3) centralized, contractor-operated, idle mode emission testing; (4) centralized, state-operated, steady-state, loaded mode emission testing, combined with safety and noise testing; (5) centralized, state-operated, idle mode emission testing; and (6) decentralized, private garage/service station operation using idle mode emission testing, with provisions for a referee station. Further, regardless of the option selected, implementation is currently being considered for the nine counties listed below.

1. Brown County
2. Dane County
3. Kenosha County
4. Milwaukee County
5. Ozaukee County
6. Racine County
7. Walworth County
8. Washington County
9. Waukesha County

Having identified several possible program configurations, the next step was to analyze each in detail so that eventually a final selection of a single option could be made. To provide the basis for a decision, a detailed comparative analysis was made of the options in terms of costs, benefits, and resource requirements; this analysis is reported in Reference 5. Using the data contained in the evaluation report, the Task Force decided on an option involving centralized test facilities conducting loaded mode emissions inspections in the nine counties defined previously (the option will be defined more explicitly later). Still undecided, however, is whether the network of central test facilities should be operated by the State or by a private contractor.

The objective of the study being reported here is to analyze the specific requirements of the option selected, primarily in terms of costs, benefits, and resource requirements, and consider in detail various tangential factors and issues that are also relevant. The major difference in this effort and the effort reported in Reference 5 is that, whereas the earlier effort focused on providing a comparative analysis of several options and therefore was rather general in treating several aspects of program implementation and operation, this effort focuses on one specific program and provides a more detailed analysis of many program factors.

BASIS AND ORGANIZATION OF THIS REPORT

Again, the intent here is to report the results of a rather detailed analysis of the particular I/M program configuration that is being considered for implementation in the State of Wisconsin. The general elements included in the analysis are (1) benefits, (2) personnel requirements, (3) adjunctive program requirements, (4) legislative requirements, (5) costs, and (6) implementation scheduling.

The general philosophy used in developing the analysis considered the fact that a number of different resources had to be utilized in order to produce an assessment that was both comprehensive in nature and specific to the State of Wisconsin. In this connection, it was considered not only appropriate, but essential to include several State agencies as sources of data and to conduct discussions with various State officials to solicit their views on different issues that are germane to the I/M program in the State. Much of the technical information generally available in the literature and from the U.S. Environmental Protection Agency was reviewed also as part of the effort, and incorporated where appropriate. Other sources of technical information used include discussions with both state officials and private contractors currently involved with running I/M programs throughout the U.S. A substantial amount of effort was also expanded on original research by staff members of GCA/Technology Division utilizing information derived from the above-mentioned sources.

The report is divided into nine principal sections including this introduction. The option being considered here is defined and discussed in detail in Section 2. Section 3 provides a discussion of the various benefits associated with implementation of the I/M program, in terms of both direct and indirect benefits, and also indicates the associated disbenefits. The resource requirements for the program are discussed in Section 4. Given prime consideration here are personnel requirements for both implementation and operation of the inspection program and operation and administration of the adjunctive programs such as consumer protection, quality assurance, and others. Section 5 provides a detailed discussion of the several supporting programs that are required. Included are discussions of (1) quality assurance, (2) mechanic training, (3) consumer protection, (4) enforcement, and (5) public information programs. Section 6 discusses the technical requirements for state legislation and mentions issues relevant to barriers or obstacles that can be encountered in the legislative process. The costs associated with implementing the program are discussed in detail in Section 7. The discussion here is in terms of both actual program costs by category, and the inspection fee requirements. Section 8 presents an analysis of the implementation staging and scheduling, as well as providing discussion concerning future expansion of the program to include additional elements (i.e., safety and noise) and increased geographical coverage. Finally, Section 9 provides a summary of the overall analysis specifically with regard to differences in each program element that occur as a function of whether the program is State or contractor operated. Following the main sections of the report are four appendices. Appendix A provides a sensitivity analysis of several variables on emission benefits and program cost. Appendix B includes a detailed description of the methods used in computing the emission inventories and emissions reductions from the I/M program. A detailed description of the methods used in computing the fuel savings benefits is presented in Appendix C, and finally, in Appendix D, a discussion of special problems associated with winter operation is developed.

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SECTION 2

PROGRAM OPTION

OPTION DEFINITION

Based on a rather detailed review of several possible inspection and maintenance program (I/M) scenarios, the State I/M Task Force selected a specific configuration that appears to be best suited for implementation in the State. Essentially, the program selected involves establishing a network of centralized emissions inspection stations where loaded mode testing will be conducted. The basic loaded mode, centralized facility concept was selected for several reasons. First, it was considered that the loaded mode option offers several advantages over the idle mode, including more comprehensive diagnostic capabilities, and more flexibility in testing procedures. Also, there will likely be an NO_x standard defined in the near future for motor vehicles and NO_x testing may become necessary as part of the I/M program; NO_x testing can only be performed with the engines under a load, as when a loaded test is performed. The major disadvantage of the loaded mode test is that it is slightly more expensive to perform since additional test equipment is required. The incremental cost difference, however, is in the range of $0.20 to $0.25 per test and is not considered to be significant.

The primary reasons for selecting the centralized facility approach over private garages concerned program control and anticipated public acceptance of the program. Specifically, the State would be able to exercise much closer control over the inspection program with fewer personnel, which should result in a much higher quality program, then would be achievable if the decentralized option were used. Further, it was considered that the public would be much less skeptical of a program where inspections were performed by an impartial entity who would not benefit from vehicles either failing or passing (primarily since repairs are not performed at the centralized facilities, nor are any individuals undergoing inspections considered "regular customers" who could bias the inspector.

One rather significant aspect of the program has not yet been determined - this concerns whether the State or a private contractor will be responsible for the construction and operation of test facilities. It is hoped that the results of the study being reported here will aid in arriving at a decision in this matter.

A number of additional elements must be defined in order to fully describe the program. The program is currently being considered for the following counties:

- Brown County
- Dane County
- Kenosha County
- Milwaukee County
- Ozaukee County
- Racine County
- Walworth County
- Washington County
- Waukesha County

The inspection frequency has been defined as annual with inspections being staggered throughout the year. Generally, inspections will be scheduled to the extent that they should be performed within a time period prior to registration. A method that could be used is to forward registration renewal material to motorists, say, 60 days before the renewal deadline. In order for the motorist to renew his registration, an emissions inspection stamp will be required on the registration form; this inspection stamp would be obtained by successfully passing the emissions inspection (or being granted a waiver) at an inspection station. The 60-day lead time would assure adequate time to obtain an inspection and a reinspection if required.

The vehicle population to be tested consists essentially of all light-duty vehicles (LDV's) and light-duty trucks (LDT's) with a gross vehicle weight (GVW) of 8,000 pounds or less. Some exemptions will be made, however, including (tentatively):

- vehicles greater than 15 years old;
- vehicles registered as farm trucks;
- research vehicles; and
- vehicles otherwise included but where at least $50 has been spent on repairs to bring the vehicle into compliance (where problems are not a result of tampering) although unsuccessfully.

A stringency level of 20 percent has been defined for this analysis. Other stringency factors and vehicle exemptions (as a function of model year) have been analyzed primarily to determine the impact that these would have on inspection fees and emissions reductions. These are reported in Appendix A. It has also been indicated that the program would operate on a mandatory inspection - voluntary repair basis during the first year. This will serve primarily to acquaint the public with the program as well as to gather baseline emissions data from which cutpoints can be established.

Several supporting programs will also be established in conjunction with the I/M program. Included are programs for: (1) public information, (2) consumer protection, (3) quality assurance, and (4) mechanics's training. These programs may be operated by the State or portions of each may be operated by contractors. These ancillary programs are described fully in Section 5.

EMISSIONS INSPECTION SCENARIO

In order to illustrate how the I/M program will work and where some of the ancillary programs tie in, the following description of the test procedure is offered.

The requirements for an emissions inspection in each instance will be related to the annual registration procedure; that is, emissions inspections will be required generally during the period when registration renewals are due. To initiate the registration renewal process, the Division of Motor Vehicles, within the Department of Transportation, will mail out registration renewal forms to motorists within the nine counties. Mailings will be staggered such that approximately one-twelfth of the total registrations are processed each month (slightly lower in winter months) approximately 2 months prior to the renewal deadline. Sometime during this 2-month period, motorists will bring their vehicles to contractor (or state) operated inspection stations.

At the inspection station, the motorist will present his renewal forms, from which certain information will be collected and entered into a computer file. This information would include:

1. A serial number which allows the test record to be retrieved and identified with the computer;
2. Exact date and time of the test;
3. The vehicle identification number (VIN);
4. Vehicle registration number;
5. Vehicle model, year, and make;
6. Owner's name;
7. Engine configuration;
8. Emissions control equipment;
9. Vehicle weight class; and
10. Test number (first, second, third, etc.).

Based on this information, test personnel can make a judgement as to whether or not the vehicle is exempt from emissions inspection. If the vehicle is exempt, the owner is given an official waiver form, printed by the computer, containing information pertaining to his particular vehicle, and the registration form is stamped, accordingly. He then either mails the completed renewal materials, (or brings them in person) to the Division of Motor Vehicles, where they are processed and the registration is completed.

If the vehicle is not exempt, it proceeds through the test lane, where it is subjected to an emissions test. Pass-fail criteria are automatically adjusted to the particular characteristics of the vehicle. If the vehicle passes inspection, the computer prints out a certificate indicating compliance, and the registration renewal form is stamped, accordingly. The motorist then mails the registration material or brings them in person to the Division of Motor Vehicles where the registration is completed.

If the vehicle fails inspection, the computer prints out a form stating which standards are being exceeded, and by how much. The owner will be advised of the probable cause for failure, and required to have the vehicle repaired and reinspected within a specified number of days. The owner will then bring the vehicle (and the failure form) to the repair station of his choice where repairs will be made to bring the vehicle into compliance with the standards. The mechanic completes a repair form, stating:

1. Repair actions performed;
2. Parts replaced;
3. Cost of parts;
4. Cost of labor; and
5. Name and address of repair facility.

The vehicle owner then brings the completed form and the vehicle back to a contractor (or state) test facility. There, the vehicle undergoes a test procedure similar to that described previously, except that no test fee is charged. If it now meets emissions standards, the registration form is stamped and the owner completes the registration process as described above.

If the vehicle fails the first retest, the vehicle owner is obliged to go through the repair and reinspection cycle once again; however, if the accumulated total of repair costs exceeds a specified repair cost limit, he may be granted a waiver as before. The second retest (and those following if necessary), however, will cost the same amount as the original test.

Should the motorist at any point in the above process have a complaint concerning either the inspection or the maintenance phase, he may register the complaint with the Department of Transportation by calling a toll-free "hotline" telephone number. Depending on the nature of the motorist's complaint, the hotline operators can take a variety of different actions in response. If the complaint is due to lack of information, the motorist can be refered to a public relations official (either contractor or state), who can provide more information about the program and its methods. If the complaint concerns actions of the contractor or questions the accuracy of the contractor's equipment, the operators refer the complaint to an appropriate offical concerned with quality assurance. The Quality Assurance coordinator would decide upon the appropriate action; he could visit the test lane in question and check the calibration of its emissions analysis equipment, or have a complaints investigator conduct either an unannounced spot check or a formal investigation of the test lane in question. If the motorist's complaint concerns actions on the part of the private automotive repair industry, the operators refer the complaint to the Trade and Consumer Protection Division of the Department of Agriculture, which has the authority to investigate consumer complaints concerning private garages. Should any complaint uncover criminal actions, then the operators could refer the complaint to the Attorney General's Office for criminal proceedings.

A general flow chart showing the registration process described above is provided in Figure 1.

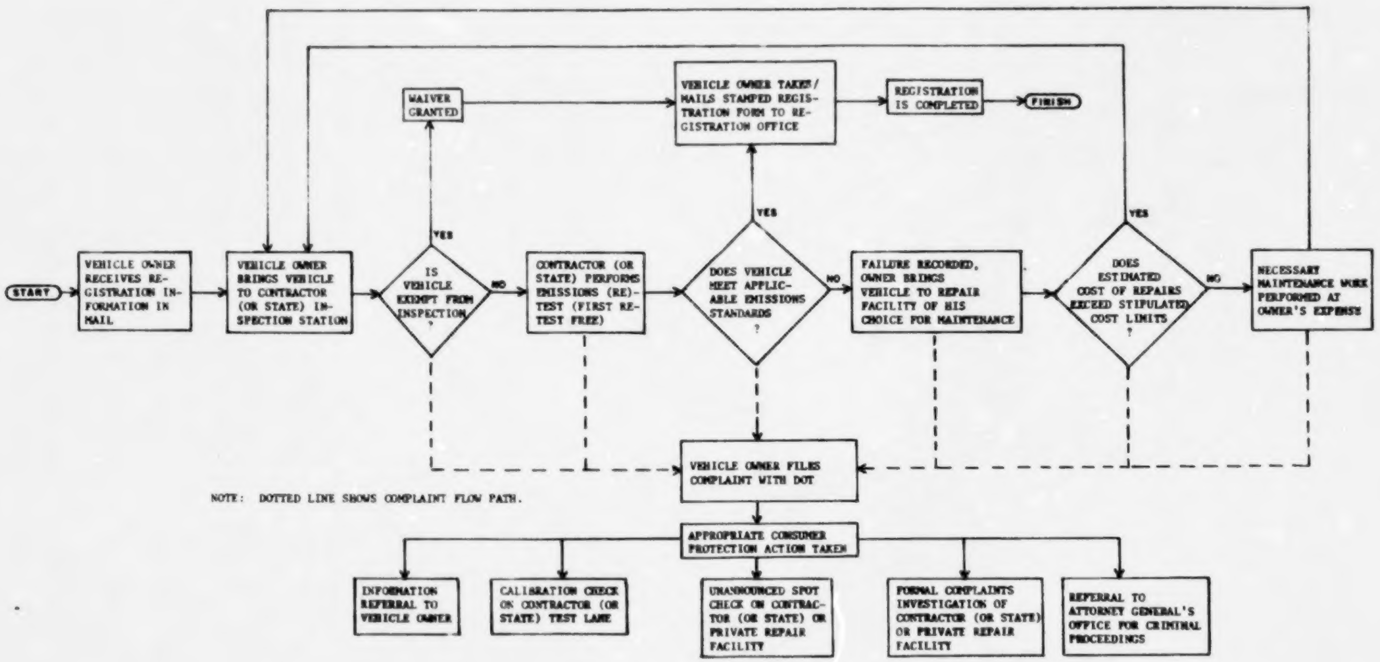
START
VEHICLE OWNER RECEIVES REGISTRATION INFORMATION IN MAIL
VEHICLE OWNER BRINGS VEHICLE TO CONTRACTOR (OR STATE) INSPECTION STATION
IS VEHICLE EXEMPT FROM INSPECTION ?
YES
NO
WAIVER GRANTED
CONTRACTOR (OR STATE) PERFORMS EMISSIONS (RE)-TEST (FIRST RETEST FREE)
DOES VEHICLE MEET APPLICABLE EMISSIONS STANDARDS ?
YES
NO
VEHICLE OWNER TAKES/MAILS STAMPED REGISTRATION FORM TO REGISTRATION OFFICE
REGISTRATION IS COMPLETED
FINISH
FAILURE RECORDED, OWNER BRINGS VEHICLE TO REPAIR FACILITY OF HIS CHOICE FOR MAINTENANCE
DOES ESTIMATED COST OF REPAIRS EXCEED STIPULATED COST LIMITS ?
YES
NO
NECESSARY MAINTENANCE WORK PERFORMED AT OWNER'S EXPENSE
VEHICLE OWNER FILES COMPLAINT WITH DOT
NOTE: DOTTED LINE SHOWS COMPLAINT FLOW PATH.
APPROPRIATE CONSUMER PROTECTION ACTION TAKEN
INFORMATION REFERRAL TO VEHICLE OWNER
CALIBRATION CHECK ON CONTRACTOR (OR STATE) TEST LANE
UNANNOUNCED SPOT CHECK ON CONTRACTOR (OR STATE) OR PRIVATE REPAIR FACILITY
FORMAL COMPLAINTS INVESTIGATION OF CONTRACTOR (OR STATE) OR PRIVATE REPAIR FACILITY
REFERRAL TO ATTORNEY GENERAL'S OFFICE FOR CRIMINAL PROCEEDINGS

Figure 1. Motor vehicle inspection and registration flow chart.

SECTION 3

I/M PROGRAM BENEFITS AND IMPACTS

INTRODUCTION

Concern for controlling automotive emissions stems from the fact that automobile traffic is responsible for approximately 75 percent of all urban carbon monoxide (CO) emissions, 50 percent of hydrocarbon (HC) emissions, and 50 percent of the oxides of nitrogen (NO_x) emissions. EPA data indicate that automobile transportation is responsible for as much as 14 to 23 percent of total air pollution costs. A study by the National Academy of Science estimated annual societal costs for this pollution (in 1969) to range from $2.2 to $5.7 billion.[1] When these costs are subsequently adjusted to account for todays inflation rates, these costs rise to $3.3 to $8.6 billion. Furthermore, a 1978 study by the National Highway Traffic Safety Administration indicates that "the prorated societal cost of air pollution caused by automobiles would be equivalent to from $24.30 to $64.30 per vehicle."[1] This same study also states that "it is conceivable that national inspection and mandatory maintenance would reduce societal cost of pollution $1.3 to $3.4 billion annually."[1]

Besides these economic benefits and the benefit of decreased emissions seen from I/M implementation, other important benefits may accrue. These include an improvement in fuel economy, increased reliability, better overall performance etc.; these types of benefits have been realized by fleets that undergo their own special maintenance programs where the actual maintenance is similar to that associated with an I/M program.

EMISSIONS REDUCTIONS

Emission reduction is the primary benefit to be derived from I/M programs. Although new vehicles are required to meet certain EPA specifications for emissions, it has been shown that emission rates for in-use vehicles deteriorate significantly unless adequate maintenance is performed. I/M has been suggested as an effective means for ensuring that the necessary routine maintenance is performed periodically, thus resulting in a significant decrease in emissions generated by the motor vehicle population.

Various levels of reductions in emissions have been noted in ongoing I/M programs. The actual reduction varies with stringency factors, climate, and other considerations. Hamilton Test Systems, under contract to the State of Arizona, noted in a 1978 report[2] that of those vehicles undergoing inspection and subsequent maintenance in the Arizona I/M program, 25 percent reduction in idle CO emissions and 41 percent reduction in idle HC emissions were shown compared to those tested in 1976 (Pre-I/M), Hamilton Test Systems claims that this program is reducing by about 250 tons, the daily amount of CO and HC emitted into the atmosphere in the Arizona counties covered by I/M, as well as saving motorists an estimated 30 million gallons of gasoline annually.[3]

Analyses performed by other state and federal agencies[4] show similar results.

Projected Emission Reductions

Motor vehicle emission inventories for both CO and HC were developed for each of the nine counties using EPA's MOBILE 1 computer routine. Input data regarding vehicle-miles of travel (VMT) by vehicle type, roadway functional class, and speed were provided by the Wisconsin Department of Transportation. It should be noted that the emission inventories developed for use here are of a preliminary nature and may be different from the rather detailed inventories currently being developed by the state for use in the upcoming State Implementation Plan revision. That the inventories presented here are of a preliminary nature does not diminish their usefulness significantly since the intent is to indicate relative emissions burden with and without an I/M program, rather than define the absolute magnitude of emissions produced. A detailed description of the methodology used in deriving the inventories is provided in Appendix B.

Inventories were prepared for each year beginning with 1982 through 1987 for each of the nine counties. Average daily emissions generated by light-duty vehicles (cars and trucks) and by all vehicles were defined for two scenarios. The first scenario reflected the vehicle population emission characteristics in the absence of an I/M program, while the second scenario reflected the compounded effects of an I/M program beginning in January 1982 on emissions during each year. Comparison of the emission totals for both the total vehicle population, and the individual vehicle classes affected by I/M indicate the impact that I/M can be expected to have. Tables 1 through 4 provide a county-by-county summary of daily CO and HC emissions, respectively, during the years 1983 through 1987, both with and without the I/M program (as defined in Section 2), for both the total vehicle population and for LDV's and LDT's only. Table 1 shows the county-by-county tabulation for CO for the years 1982 through 1987 for light-duty vehicles while Table 2 shows the same data with regard to HC emissions. Tables 3 and 4 are similar to Tables and 1 and 2 except that emissions from the entire vehicle population are shown. Of particular interest is the reduction achievable by 1987 for the LDT and LDV population. EPA requires that the program produce at least a 25 percent reduction in emissions in 1987 from vehicles included in the program (LDV's and LDT's) compared to the emissions that would be produced by these same vehicles in 1987 without I/M. The last column in Tables 1 and 2 indicate that the proposed I/M program will, on the average for all counties, achieve a reduction of 50 percent and 42 percent for CO and HC, respectively, indicating that the program configuration is more than adequate to meet EPA's minimum standards. The reductions by year are shown graphically for CO and HC in Figures 2 and 3, respectively, for the total nine counties, and in Figures 4 and 5 for only the seven counties in the Milwaukee area for CO and HC, respectively.

An analysis of the effects of varying the stringency factor was also conducted, again using MOBILE 1. Average daily CO and HC emissions were computed for 1983 and 1987 using the I/M program scenario discussed in Section 2, except that stringency factors of 10 through 40 percent were substituted for the

TABLE 1. PROJECTED CARBON MONOXIDE EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR LDV's AND LDT's ONLY

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M^a	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Milwaukee 7-County Area Freeways and arterials																
Kenosha	41,600	36,011	29,409	19	33,436	23,974	28	30,396	19,723	36	28,030	15,877	43	25,966	12,878	50
Milwaukee	286,388	252,433	203,087	20	223,184	159,390	29	199,016	127,633	36	179,223	100,029	44	163,319	80,265	51
Ozaukee	24,073	19,922	16,040	19	18,013	12,877	29	16,419	10,536	36	14,950	8,413	44	13,778	6,769	51
Racine	50,189	43,196	35,432	19	40,707	29,224	28	37,091	23,879	36	33,715	19,073	43	31,016	15,354	50
Walworth	26,725	22,507	18,208	19	20,696	14,776	28	18,798	12,211	35	17,618	10,090	43	16,697	8,407	50
Washington	27,636	24,790	20,076	19	22,383	16,171	28	20,355	13,265	35	18,703	10,766	42	17,367	8,807	49
Waukesha	91,326	82,326	66,661	19	74,336	53,606	28	67,012	43,710	35	61,671	35,088	43	56,866	28,382	50
7-County, locals	80,041	70,023	62,012	19	68,579	49,068	28	60,016	39,130	36	54,907	31,062	43	50,191	24,833	50
7-County total	630,085	562,887	452,805	19	501,212	359,086	28	450,602	290,087	36	408,817	231,196	43	375,200	185,695	50
Brown County																
Freeways, arterials, and locals	65,403	57,220	46,230	19	51,663	37,166	28	46,926	30,430	35	42,842	24,515	43	39,341	19,912	50
Dane County																
Freeways, arterials, and locals	124,237	111,370	90,077	19	106,051	71,835	28	90,391	58,530	35	82,662	46,894	43	75,918	37,878	50
Total I/M area	817,735	730,443	588,912	19	652,906	467,895	28	588,200	379,055	36	534,321	302,605	43	490,459	243,485	50

^{a}Assumed I/M stringency level is 20 percent

TABLE 2. PROJECTED HYDROCARBONS* EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR LDV'S AND LDT'S ONLY

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Milwaukee-7-County Area Freeways and Arterials																
Kenosha	5,039	4,460	3,861	11	3,906	3,227	19	3,503	2,661	26	3,266	2,160	34	2,840	1,777	37
Milwaukee	33,174	28,810	24,427	15	25,211	20,107	20	22,347	16,188	28	20,122	12,916	36	18,462	10,438	43
Ozaukee	2,795	2,462	2,135	13	2,182	1,775	19	1,955	1,456	26	1,762	1,172	33	1,619	959	41
Racine	6,150	5,419	4,677	14	4,889	3,885	19	4,316	3,186	26	3,898	2,566	34	3,589	2,097	42
Walworth	3,181	2,817	2,453	13	2,506	2,052	18	2,252	1,696	25	2,083	1,411	32	1,963	1,190	39
Washington	3,606	3,071	2,660	13	2,712	2,216	18	2,419	1,818	25	2,194	1,485	32	2,030	1,229	39
Waukesha	11,606	10,106	8,761	13	8,936	7,275	19	7,991	5,961	25	7,215	6,023	33	6,636	3,952	40
7-County, locals	9,351	8,140	6,853	16	7,158	5,586	22	6,375	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5,481	2,919	46
7-County total	74,680	65,297	56,036	14	57,498	46,121	20	51,246	37,448	27	46,336	30,128	35	42,540	24,561	42
Brown County																
Freeways, arterials, and locals	7,109	6,307	5,365	15	5,635	4,471	21	5,097	3,675	28	4,684	2,986	36	4,343	2,457	43
Dane County																
Freeways, arterials, and locals	14,605	12,854	11,011	14	11,395	9,121	20	10,227	7,458	27	9,293	6,029	35	8,590	4,937	43
Total I/M area	96,394	84,458	72,412	14	74,528	59,713	20	66,570	48,581	27	60,313	39,143	35	55,481	31,955	42

*Nonmethane HC only.

TABLE 3. PROJECTED CARBON MONOXIDE EMISSIONS (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR ALL VEHICLES

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Milwaukee-7-County Area Freeways and Arterials																
Kenosha	50,435	46,606	39,481	15	42,791	33,329	22	39,465	28,591	28	36,333	24,183	33	33,874	20,787	39
Milwaukee	399,872	362,056	312,711	14	324,444	260,657	20	291,772	220,390	24	263,869	185,475	30	241,937	158,883	34
Ozaukee	29,261	26,976	23,096	14	24,690	19,555	21	22,695	16,813	26	20,793	14,255	31	19,310	12,300	36
Racine	65,810	60,610	51,847	14	55,366	43,780	21	50,709	37,508	26	46,322	31,680	32	42,884	27,222	37
Walworth	36,288	33,995	29,733	13	31,407	25,686	18	29,080	22,494	23	27,363	19,836	28	26,095	17,805	32
Washington	38,404	35,600	30,887	13	32,527	26,315	19	29,803	22,713	24	27,496	19,557	29	25,687	17,128	33
Waukesha	130,558	126,934	111,076	12	110,364	95,415	18	106,820	82,918	22	97,950	71,389	27	91,008	62,525	31
7-County, locals	121,240	108,592	93,390	14	96,368	76,857	20	85,876	64,190	25	77,630	53,786	30	71,172	45,864	36
7-County total	877,978	801,369	692,219	14	723,915	581,594	20	656,220	495,817	24	597,756	420,141	30	551,967	362,514	34
Brown County																
Freeways, arterials, and locals	78,025	71,456	60,458	15	64,991	50,514	22	59,346	42,858	27	54,332	36,006	34	50,336	30,727	39
Dane County																
Freeways, arterials, and locals	162,334	148,943	127,443	14	135,340	107,123	21	123,473	91,414	26	112,922	77,354	31	104,619	66,580	36
Total I/M areas	1,118,477	1,021,770	880,122	14	924,246	739,231	20	839,039	629,889	25	756,010	533,501	29	706,942	459,821	35

TABLE 4. PROJECTED HYDROCARBON EMISSIONS* (kg/day) AND PERCENT REDUCTIONS ACHIEVABLE FOR ALL VEHICLES

County	1982	Daily emissions in 1983			Daily emissions in 1984			Daily emissions in 1985			Daily emissions in 1986			Daily emissions in 1987		
	Without I/M	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction	Without I/M	With I/M	Percent reduction
Milwaukee-7-County Area Freeways and Arterials																
Kenosha	5,789	5,192	4,573	12	4,601	3,823	17	4,147	3,194	23	3,760	2,643	30	3,489	2,222	36
Milwaukee	41,241	35,997	31,714	12	31,510	26,130	17	27,903	21,484	23	25,090	17,620	30	22,981	14,693	36
Ozaukee	3,304	2,923	2,580	12	2,593	2,172	18	2,321	1,804	22	2,089	1,486	29	1,917	1,241	35
Racine	7,262	6,408	5,628	12	5,680	4,732	17	5,097	3,935	23	4,598	3,235	30	4,228	2,703	36
Walworth	3,990	3,511	3,123	11	3,121	2,646	15	2,795	2,219	20	2,573	1,883	27	2,413	1,621	33
Washington	4,240	3,737	3,312	11	3,297	2,781	16	2,933	2,313	21	2,654	1,925	27	2,444	1,625	34
Waukesha	14,304	12,614	11,176	11	11,142	9,393	16	9,923	7,812	21	8,910	6,449	28	8,182	5,400	34
7-County, locals	12,089	10,954	9,548	13	9,297	7,620	18	8,286	6,295	24	7,571	5,243	31	7,044	4,448	37
7-County total	92,099	80,896	71,006	12	71,270	59,317	17	63,404	49,061	23	57,261	40,484	29	52,678	33,950	36
Brown County																
Freeways, arterials, and locals	8,218	7,319	6,334	13	6,547	5,342	18	5,919	4,460	25	5,418	3,700	32	5,043	3,116	38
Dane County																
Freeways, arterials, and locals	17,393	15,380	13,438	13	13,648	11,283	17	12,239	9,383	23	11,110	7,759	30	10,269	6,519	37
Total I/M area	117,710	103,595	90,778	12	91,465	75,942	17	81,562	62,904	23	73,787	51,943	30	67,980	43,585	36

*Nonmethane HC only.

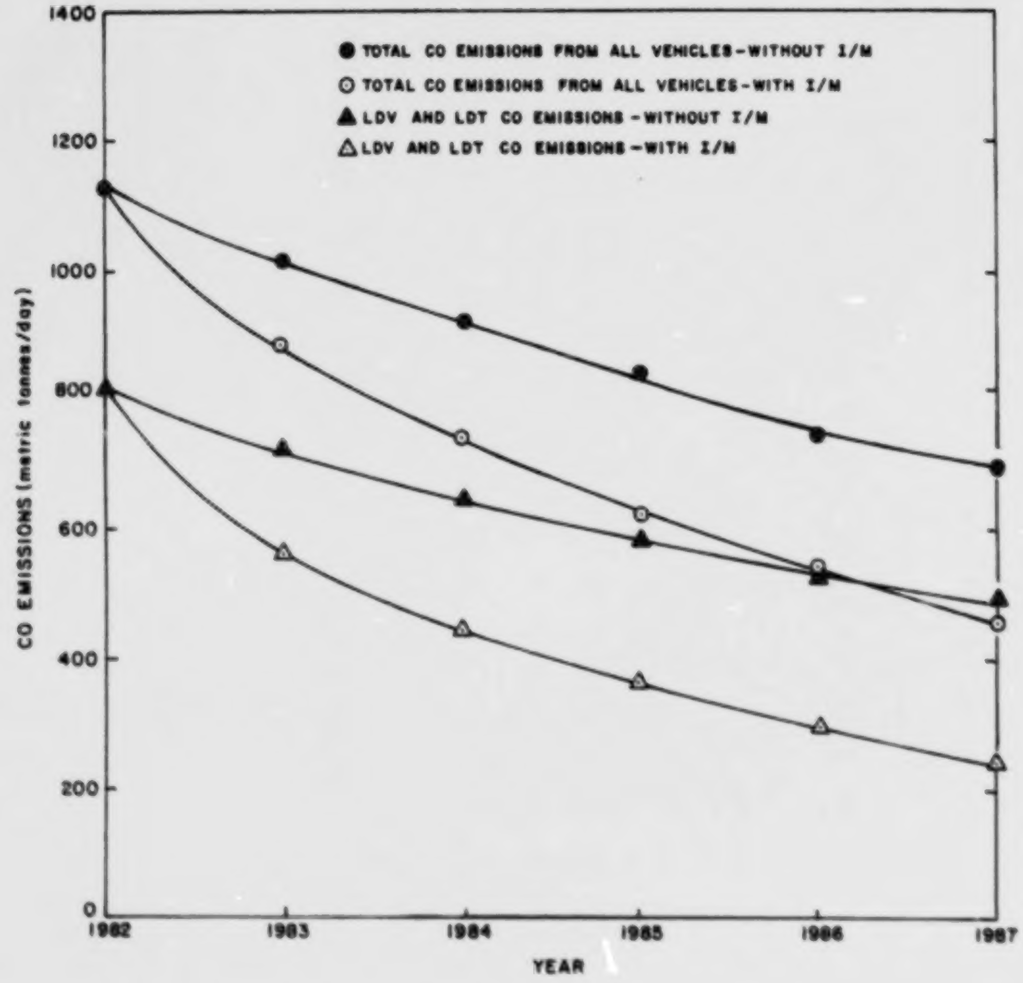

Figure 2. Daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M in nine Wisconsin counties - 1982 through 1987.

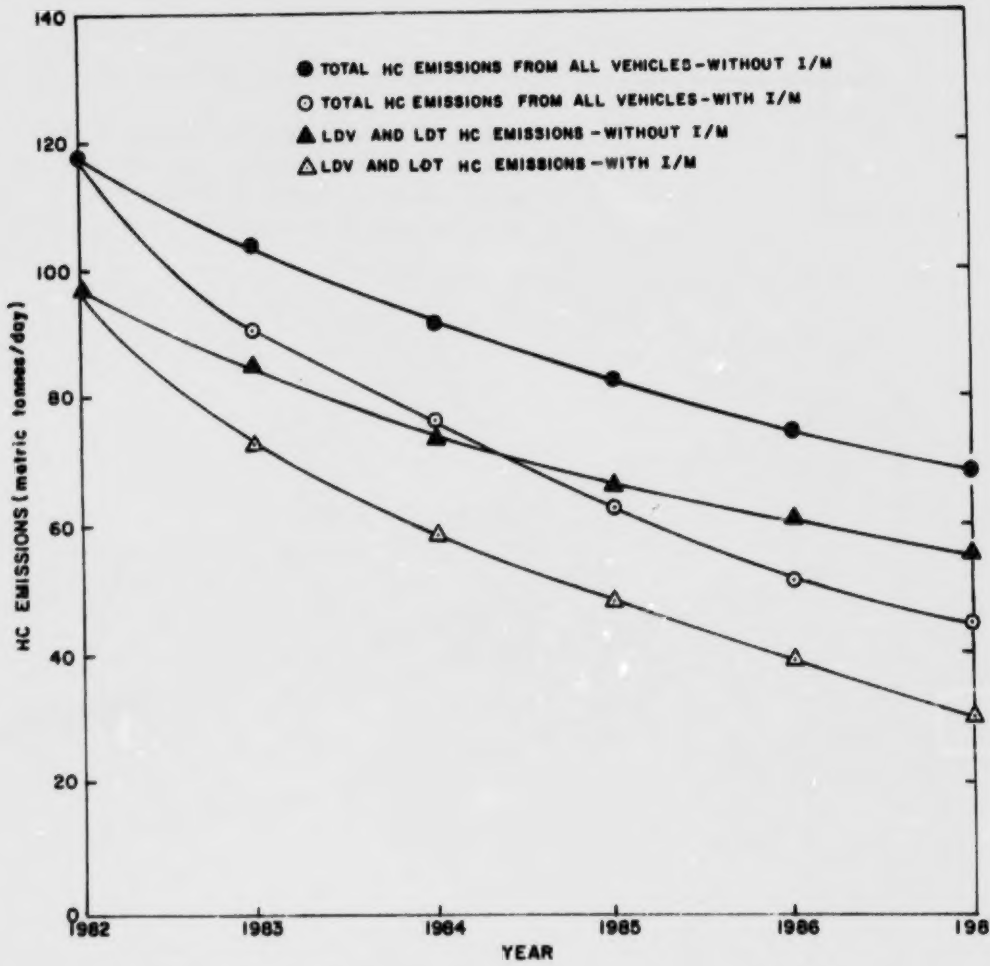

Figure 3. Daily HC emissions by year for LDV's and LDT's, and all vehicles, with and without I/M in nine Wisconsin counties - 1982 through 1987.

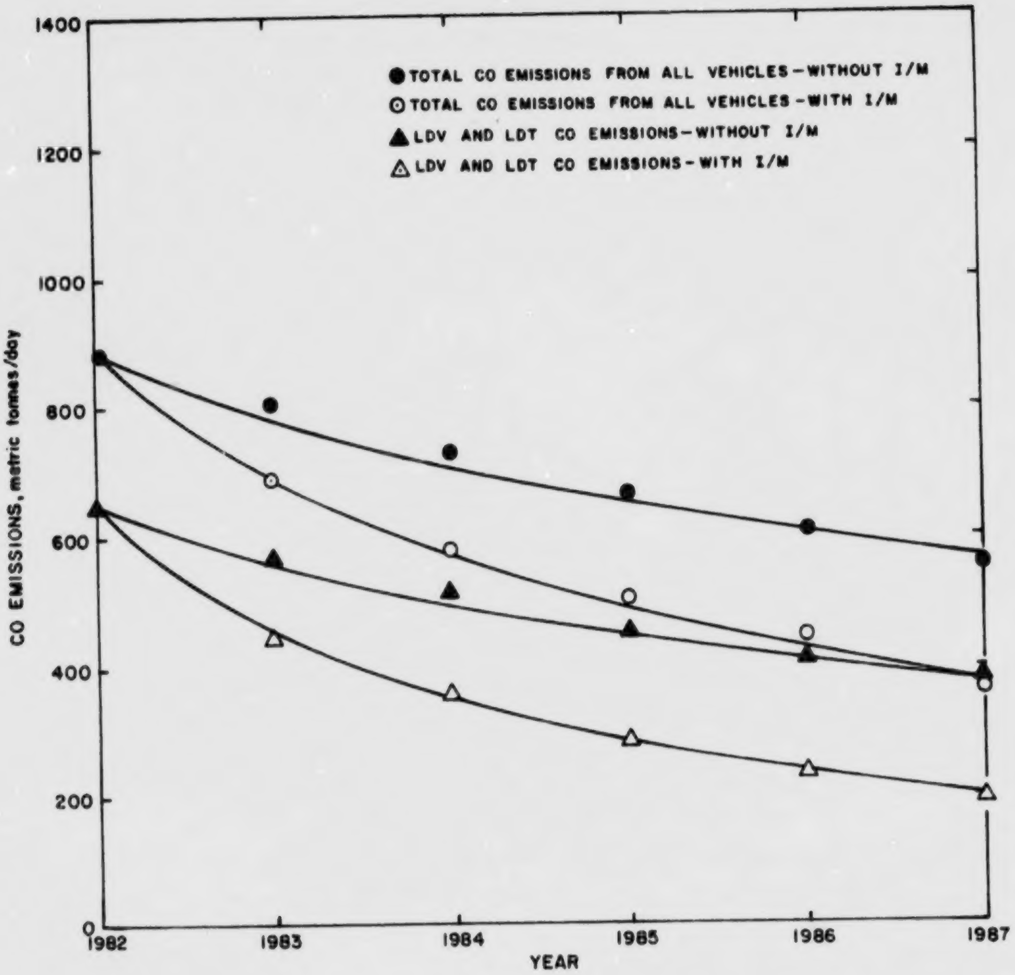

Figure 4. Daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M in the Seven County Greater Milwaukee area - 1982 through 1987.

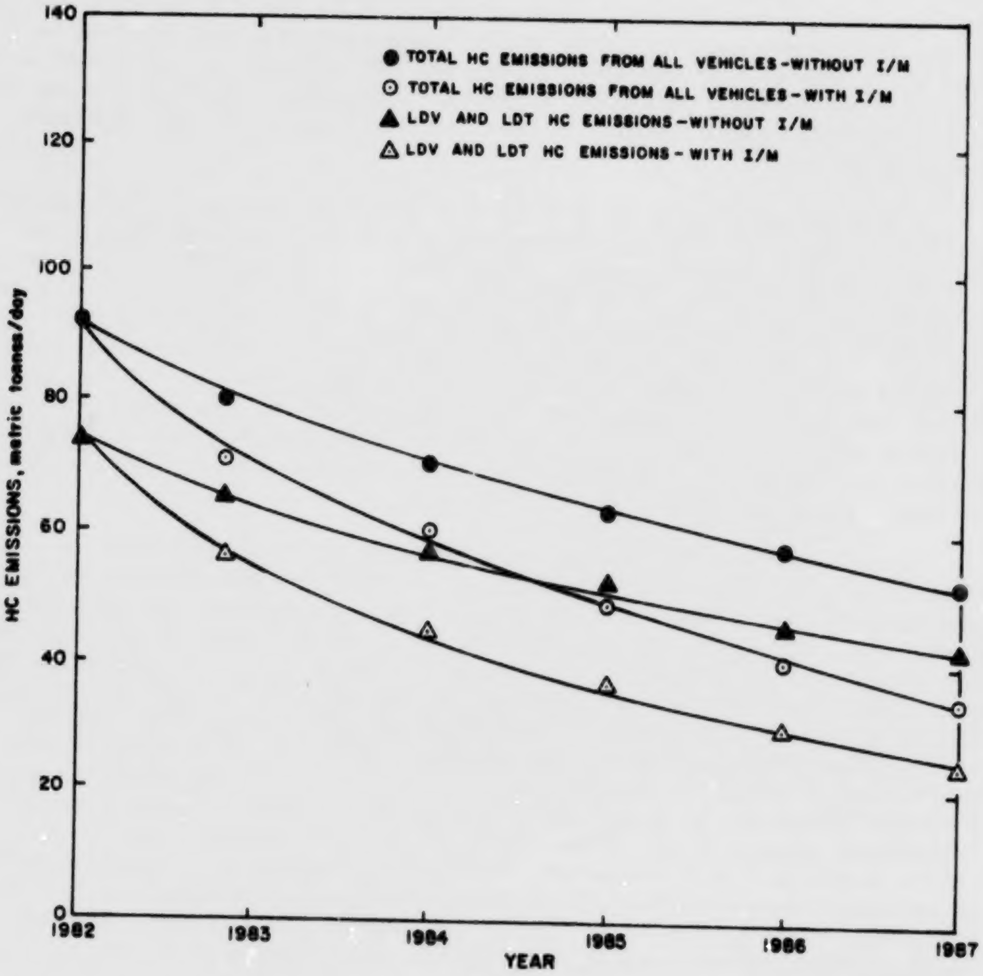

Figure 5. Daily HC emissions by year for LDV's and LDT's, and all vehicles with and without I/M in the Seven County Greater Milwaukee area - 1982 through 1987.

20 percent rate. A summary of the impact that the different stringency factors have on CO and HC is presented in Table 5; these data are also displayed graphically in Figures 6 and 7. These figures show quite dramatically that increasing the stringency level above 20 percent results in very slight additional reductions in CO or HC emissions.

Fuel Economy

Typically, the types of repairs required by the I/M program include either carburetor adjustments or minor engine tune-ups. Several studies have shown that the types of repairs associated with I/M affect fuel consumption as well as reduce emissions. Although a general improvement in fuel economy is reported in the studies, there remains a question with regard to the magnitude of the improvement.

A report[1] published in 1978 by the National Highway Traffic Safety Administration noted that vehicles undergoing I/M related repairs showed an increase of 4.7 percent in fuel economy. This study also noted that fuel savings nationwide could be projected if I/M programs were implemented on a national scale; these projections show an annual gasoline savings of about 1.8 billion gallons. It is noted, however, that these projections are based only on one specific study, therefore the results and conclusions may not be applicable in all instances. The important point here, however, is that relatively minor problems such as a maladjusted carburetor or ignition timing can have an effect on fuel economy and these types of problems become readily apparent during routine emission inspections.

Champion Spark Plug Company, along with aid from the American Automobile Association, conducted vehicle tests nationwide to gather data on motorist maintenance habits and their effect on fuel consumption and emissions. This study concluded that, after a tune-up, test cars showed an average fuel economy improvement of 11.36 percent. Even as a result of simply replacing the spark plugs, fuel consumption was seen to improve by 3.68 percent.[5] The survey revealed a lack of vehicle maintenance by the motoring public. Of the cars surveyed, 79 percent needed some maintenance work to regain the optimum performance level, and the type of maintenance needed most often was ignition and carburetion service. To quote the report, the program "clearly pointed out the advantages gained by new plugs alone or complete engine tune-up in providing better mileage, lower emissions, and better overall driving performance."[5] Of interest when considering I/M program vehicle coverage, is the fact that the oldest cars in the study (pre-1968) showed the greatest improvement (in miles per gallon) in fuel economy of all year groups.

Another fuel economy improvement study was undertaken by Jerome Panzer of Exxon Research and Engineering Company.[6] Using a 50 percent rejection rate, a pre-1975 vehicle population, and subsequent tune-ups for failed vehicles, the average gain in fuel economy between annual inspections for study vehicles was about 7.5 percent. This figure has been adjusted to account for estimated deterioration; without considering this, a 13 percent immediate improvement is indicated. Panzer found that repairs carried out to correct only emissions produce about three-fourths of the fuel economy benefit achieved by a complete tune-up. Also of interest is the fact that, when the effect of repairing the

TABLE 5. EFFECT OF VARYING THE STRINGENCY FACTOR ON CO AND HC EMISSIONS REDUCTION POTENTIAL

Area	Pollutant	Year	LDV's and LDT's only daily emissions* in kg/day and (percent reduction)†					All vehicles daily emissions* in kg/day and (percent reduction)†				
			Without I/M	I/M with 10% stringency	I/M with 20% stringency	I/M with 30% stringency	I/M with 40% stringency	Without I/M	I/M with 10% stringency	I/M with 20% stringency	I/M with 30% stringency	I/M with 40% stringency
9-Counties	CO	1983	730,613	636,866 (13%)	588,912 (19%)	561,656 (23%)	547,127 (25%)	1,021,770	928,038 (9%)	880,122 (14%)	852,827 (17%)	838,299 (18%)
		1987	490,659	281,074 (43%)	243,485 (50%)	220,936 (55%)	208,912 (57%)	706,942	497,360 (29%)	459,821 (35%)	437,223 (38%)	423,384 (40%)
	HC	1983	84,458	74,161 (12%)	72,412 (14%)	71,411 (15%)	70,864 (16%)	103,595	92,528 (11%)	90,776 (12%)	89,776 (13%)	89,231 (14%)
		1987	55,481	34,820 (37%)	31,955 (42%)	30,237 (46%)	29,097 (48%)	67,990	46,451 (32%)	43,585 (36%)	41,865 (38%)	40,730 (40%)
7-County Greater Milwaukee Area	CO	1983	562,007	489,778 (13%)	452,805 (19%)	431,840 (23%)	420,660 (25%)	801,369	729,154 (9%)	692,219 (14%)	671,215 (16%)	660,035 (18%)
		1987	375,200	214,498 (43%)	185,695 (50%)	168,532 (55%)	159,738 (57%)	551,967	391,266 (29%)	362,514 (34%)	345,301 (37%)	334,892 (39%)
	HC	1983	65,297	57,383 (12%)	56,036 (14%)	55,268 (15%)	54,847 (16%)	80,896	72,353 (11%)	71,004 (12%)	70,237 (13%)	69,817 (14%)
		1987	42,450	26,754 (37%)	24,561 (42%)	23,250 (45%)	22,386 (47%)	52,678	36,144 (31%)	33,950 (36%)	32,643 (38%)	31,778 (40%)

*Total daily CO and nonmethane HC emissions

†Percent of analysis year emissions without I/M

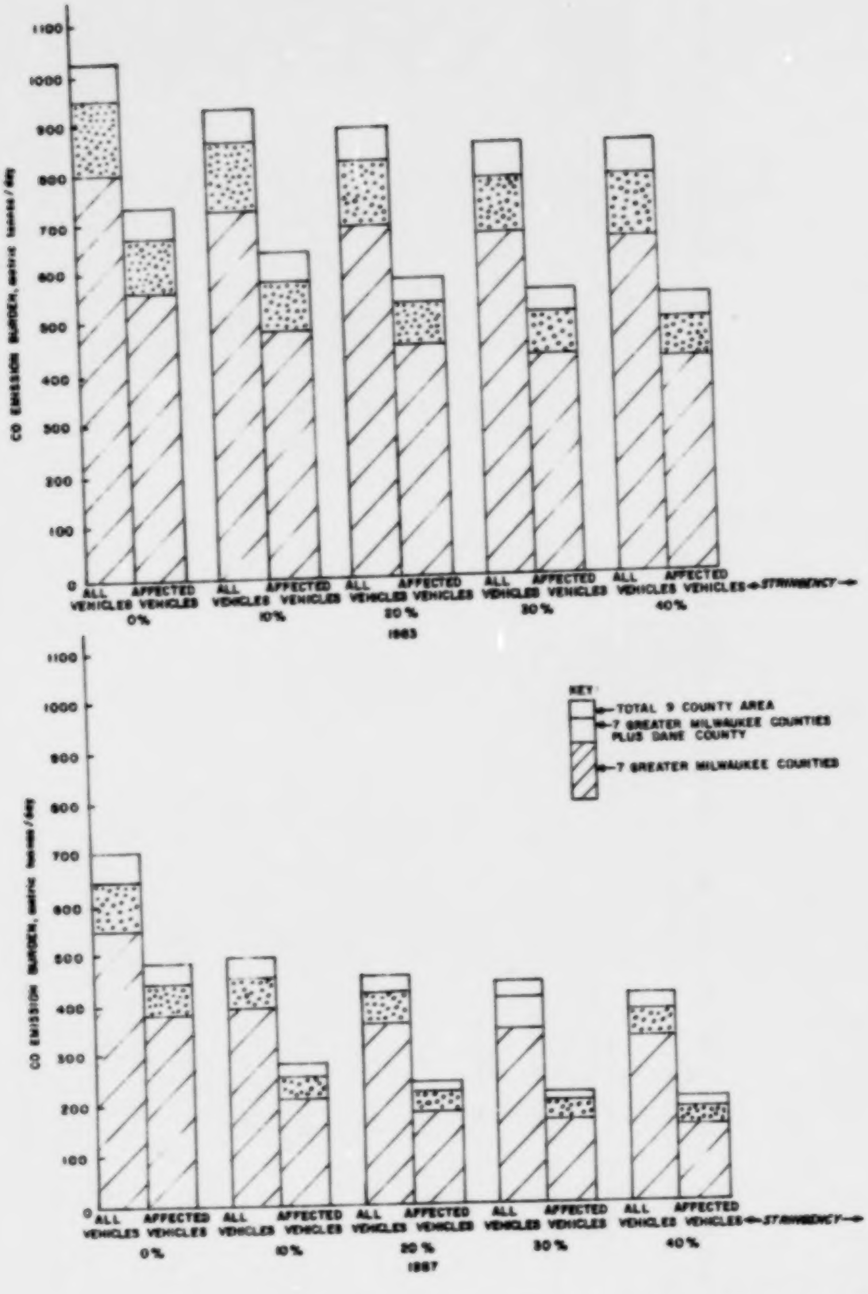

Figure 6. Effect of varying the stringency level on CO emissions for LDV's and LDT's, and all vehicles for 1983 and 1987.

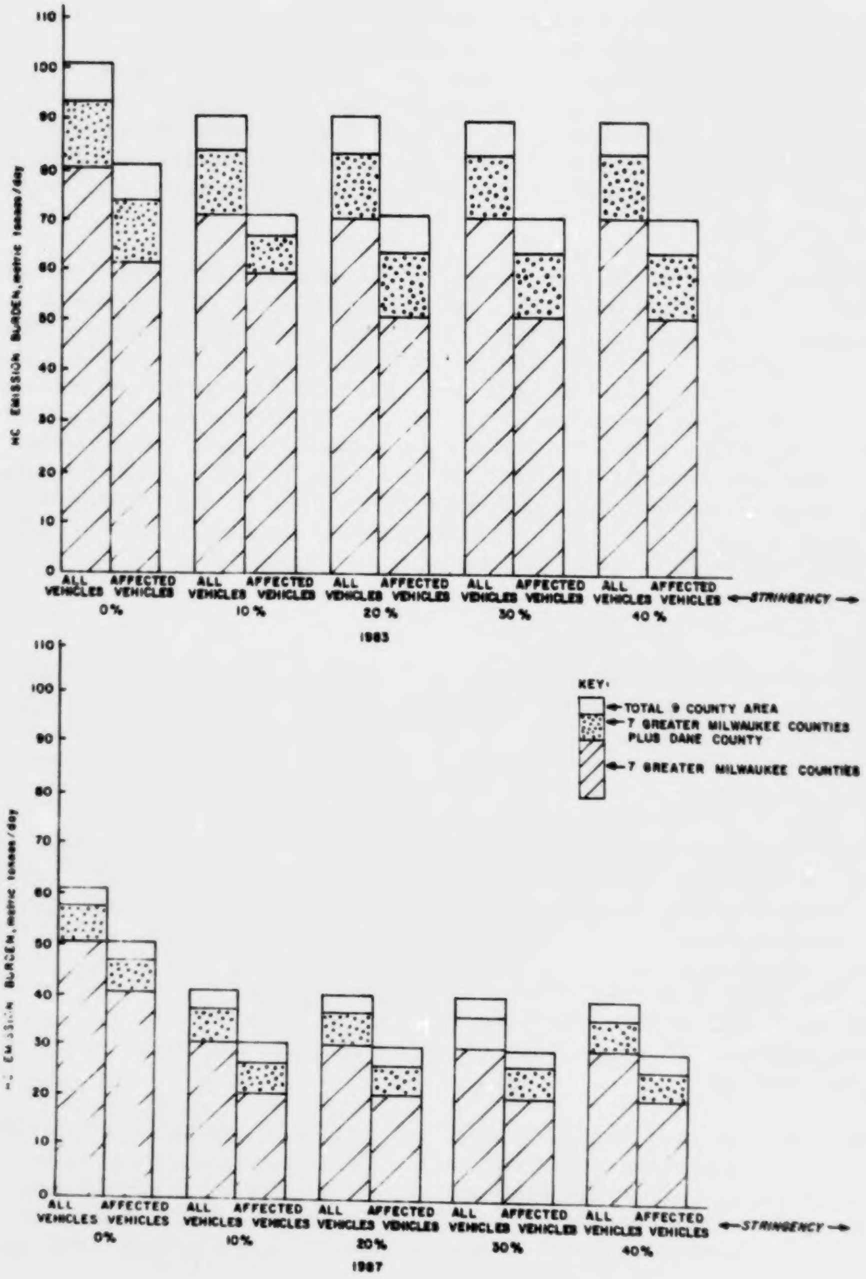

Figure 7. Effect of varying the stringency level on HC emissions for LDV's and LDT's, and all vehicles for 1983 and 1987.

50 percent of the vehicles tested that were the highest emitters is spread out over the total car population, the fuel economy drops to an estimated 2 percent.

There are other interesting conclusions to note from this study. For instance, it was found that as little as a 40 pound weight factor in a car has a detectable effect on fuel consumption. Also, at the lowest rejection rates, the malfunctions repaired were those having the greatest impact on fuel economy (e.g., misfires). Therefore, the rate of fuel economy improvement diminishes as the rejection rate rises. There was no significant fuel economy change noted in tuning up the 50 percent of the study cars that passed the emissions tests.

For the purposes of this study, it is assumed that the fuel economy improvement for vehicles that fail the emissions test and therefore undergo maintenance, will be 7 percent averaged over a year. Applying this to the projected vehicle population in the nine counties in 1987, the failure rate chosen - 20 percent, and the relative travel distribution by various model year vehicles, it is estimated that during 1987, approximately 5.76 million gallons of gasoline would be saved as a result of the I/M program. Assuming further that the cost of a gallon of gasoline in 1987 is $0.80, the fuel cost savings associated with the 5.76 million gallons of fuel conserved is $4.6 million. A detailed discussion concerning the derivation of the fuel savings associated with the program is presented in Appendix C.

Impact on Vehicle Performance and Life

The effects of inspection and maintenance programs on vehicle performance and life are currently under study. Preliminary analyses in this area have focused on various vehicle fleets and indicate that I/M does have a positive effect on both vehicle performance and vehicle life, although specific, quantitative statistics are not yet available.

Some of the more notable findings to date regarding vehicle performance come out of Phoenix, Arizona. In order to reduce on-the-road failures, a rather comprehensive preventative maintenance inspection program was implemented for the City's vehicle fleet. Results of the program were closely monitored resulting in the determination that: (1) the fuel consumption rate during the first 6 months of the program decreased approximately 10 percent, much of which was attributed directly to the program; and (2) a significant decrease occurred in the number of vehicles breaking down on the road and requiring towing.

An aspect of the benefits that has not been adequately studied to date concerns the deterioration of emission characteristics over time subsequent to repairs being performed. Several studies have been performed that indirectly consider the subsequent deterioration of emissions but consistent conclusions regarding the long-term (over a 1-year period, say) effect have not been reached.

Indirect Benefits and Impacts

The improvement in fuel economy that results from an I/M program is an important benefit for vehicle owners. The vehicle owners view the fuel savings as an individual economic issue, whereas the total or aggregate fuel savings is actually an important energy conservation savings as well.

The cost savings that result from the improvement in fuel economy, the better engine performance and increased longevity may not be readily apparent to the individual motorists, although the fleet owners who have good long-term records will be able to perceive these benefits over time. It is important, therefore, that the motoring public be made aware of these benefits.

On the other hand, the obvious costs of repairs for failed vehicles will be readily apparent to the vehicle owners. The question arises, however, as to how much of these repair costs should be directly attributable to the I/M program. While it is true that a vehicle owner may be required to make a repair if his vehicle does not comply, it is inappropriate to charge the entire cost of mandated repairs to I/M requirements. I/M will cause vehicles to be repaired more completely and frequently than they would be without it. Indeed, this is the purpose of I/M. But a fraction of the repair cost would have been incurred regardless. Estimates of the magnitude of this fraction vary from 25 to 75 percent.

This issue of mandated repairs is central to I/M program externalities. The costs of these repairs are a burden on the vehicle owner. These costs will not be distributed evenly throughout the population. It is safe to assume that older vehicles will generally be owned by individuals at the lower end of the economic spectrum. These vehicles are more likely to require repairs than newer vehicles. If these vehicles fail to meet I/M standards more frequently than newer vehicles, the burden of I/M could fall unevenly on lower income segments of the population. This uneven impact is partially mitigated by establishing exemptions to compliance based on vehicle age and ceilings on the dollar value of mandated repairs.

As the vehicle mix changes over time, this problem will become less severe than it may be now. As older vehicles, those that are costly to maintain to standards, dropout of the vehicle population, they will be replaced by used vehicles that have been included in the mandatory I/M program are, therefore, likely to be in better overall condition. It can be expected that these vehicles would require less expensive maintenance throughout their serviceable life.

This trend will be countered to a certain extent because vehicles filtering down via resale will be equipped with various emissions control devices. This equipment has been covered by a 50,000-mile warranty by manufacturers as a result of federal warranty requirements. The useful life of emission control devices covered by warranty is not presently known. Of course, if these devices prove to be as durable as the vehicles in which they are installed, they will not create extra repair costs as these vehicles age. Should they require replacement after 50,000 miles but prior to the end of a vehicle's life, the cost of doing so will fall on the used car owner who is generally in a lower income category than the initial purchaser. Replacing control devices could become costly. Thus, if these devices do require extensive maintenance to be kept operating correctly near the end of a vehicle's life, I/M may impose a greater financial burden on the used vehicle owner than it will on the public at large. If this proves the case, it will add another reason for exempting vehicles reaching a certain age.

Establishing an accurate average cost for repairs that are induced by I/M is difficult. General data from existing programs can provide a starting point in contemplating the magnitude of this figure. For California's Riverside Trial Program, the average repair cost for a vehicle failing inspection, including parts, tax and labor was $11.42 when adjusted to remove voluntary repairs made at the time required repairs were performed.[7] This figure applies repair costs for a 40 percent stringency rate over the entire vehicle population tested. Average repair values for California were $27.33 and $32.08 for idle- and loaded-mode testing. In a similar study in Michigan these figures were $23.29 and $36.56.[8]

In these studies, the repair costs directly attributable to I/M may not be accurate. This is for two reasons. One reason, mentioned earlier, is that some of these repairs would have been made anyway, even if the I/M program was not in existence. Second, no accounting is made, nor can it be made with current data, of extra repair costs incurred in anticipation of inspection. It is likely that some vehicles that pass the first time through inspection have attained higher maintenance standards than they would have otherwise in order to avert failure and the inconvenience of traveling to the inspection site a second time for retesting.

The nature of repairs required to meet I/M standards for failed vehicles can help shed light on the burden noncomplying vehicle owners must bear. The Riverside Trial Program found that 66 percent of the diagnosed repair evaluations consisted of an imbalance in the idle air-to-fuel ratio. An additional 18 percent of vehicles failing were diagnosed as experiencing rich carburetion. These problems are neither difficult nor costly to rectify. Thus, the average repair cost figures may be somewhat misleading. Most vehicles requiring service will experience costs lower than the average reported figure. A small portion will have bills considerably in excess of the average reported figure. If these bills fall into waiver regions (either an absolute dollar limit on repair cost or a percentage of vehicle value figure), then assuming an average repair cost for all failed vehicles can overstate the total repair cost burden to vehicle owners; that is, the total cost of required repairs (those that do not exceed cost limit categories) may be less than the total cost of repairs reported by an I/M sequence.

There are other costs to vehicle owners relating to I/M in addition to repair costs and the vehicle inspection fee. Two major costs to consider are time and operating costs experienced traveling to and from inspection sites. Actual operating costs can be calculated fairly accurately. Time costs have a much more subjective nature.

The vehicle miles traveled (VMT) induced as a result of an I/M program depend on the size of the affected vehicle population, density of that population, siting of inspection stations, and so forth. Estimates of total induced

VMT can be used to determine total vehicle operating costs and time spent on those induced VMT. Applying an average emission level to these extra VMT can provide a rough estimate of emissions induced by the implementation of I/M.

An elusive but probably a more significant figure is the time cost of travel to and from, and waiting time at inspection facilities. There are evaluative decisions about the value of time spent traveling, waiting time, and so on that must be resolved before a dollar figure can be computed. The issue is complicated because different people value their time differently and even value different types of time differently (e.g., time spent driving versus time spent waiting at an inspection site). The value an individual places on his time is related to his income level. As income rises, an individual tends to value his time more highly.

Estimating operating and time costs is further complicated because it is difficult to determine what portion of these costs to assign directly to I/M requirements. Many times the trip to an inspection site is combined with other errands and stops. The total costs, time and operating, of such trips should be allocated between the different purposes served by them. It is also difficult to determine how circuitous the I/M stop is. It may require a substantial detour in some cases and none in others.

A potential benefit for the vehicle owner is money saved by utilizing diagnostic information provided by I/M to correct small problems before they become serious. By prompting repairs early-on, I/M can help eliminate substantial costs to the vehicle owner.

This brief overview of the impacts I/M may have for vehicle owners serves to emphasize the complex nature of program costs and benefits. A qualitative evaluation of them helps assure that they will be considered when implementing I/M.

Impact on the Automotive Repair and Parts Industry

It is safe to state that I/M implementation will result in an increased demand for repair activities and replacement parts. To the extent that I/M induces new repairs that would not have been performed otherwise, the repair industry will directly benefit from the program. Additionally, I/M will place a requirement on the repair industry regarding training; that is, since new types of repairs will be in demand, it is necessary for the repair industry to become trained to perform these repairs. Mechanic training program requirements are discussed in detail in Section 5.

Job creation will be necessary to increase the supply of repair personnel to meet new demand. The ratio of mechanics to vehicles has been declining significantly over the last few decades. In 1950 there were 73 vehicles for every mechanic nationwide. By 1975 this ratio decreased to one mechanic available for every 146 vehicles. This trend cannot continue if I/M becomes a reality. As emissions regulations increase, vehicle complexity will extend repair times for existing components. New subsystems will also be created that will eventually require repair and the demand for mechanic time will increase for each vehicle.

In addition to recruiting and training new mechanics, existing personnel should undergo at least a limited retraining phase to orient them to the purposes and goals of I/M and emissions control. In some cases the needs of I/M are in conflict with maintenance standards now existing that emphasize high engine performance. It is important that the repair industry be aware of the different criteria demanded by I/M so that appropriate repairs can be made.

No matter how responsive the supply of mechanics is to this increase in demand, some lag is inevitable. Because of this, windfall profits may accrue to existing members of the industry for an initial time period. The tight supply situation could result in some overcharging. This should be brief, as new mechanics will be trained and in turn enter the labor pool as the public becomes aware of the implications of I/M. As the supply of repair personnel expands, the consumer will again be able to choose among many repair shops. This will make overpricing practices more difficult.

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SECTION 4

NETWORK AND PERSONNEL REQUIREMENTS

I/M NETWORK

In order to derive network requirements for an I/M program to be established by 1982, it is necessary to make reasonable estimates as to the size of the vehicle population to be served by such a program. Not all motor vehicles registered in the affected counties will be subject to inspection; for various reasons, certain vehicle classes have been exempted. These are: those vehicles having a gross weight of over 8,000 pounds, those vehicles registered as farm trucks, those vehicles over 15 years old (tentatively), and special purpose vehicles such as prototypes or experimental models.

Using detailed county vehicle registration data provided by the Wisconsin Department of Transportation, estimates were made of the 1982 and 1987 inspectable vehicle populations using two different methods. The 1982 and 1987 figures are of interest because the Clean Air Act Amendments of 1977 require full program implementation by 1982, and network facilities will be designed to meet the demands of the 1987 vehicle population. One method of projection is to take the 1978 inspectable vehicle population for each of the nine counties and increase it at a constant annual rate of 3 percent. This growth rate approximates the annual statewide growth in registrations; using this method results in a 1982 projection of 1,329,209 and a 1987 projection of 1,540,918 inspectable vehicles in the nine counties.

While a constant annual growth rate of 3 percent may be useful in making statewide vehicle population estimates, it may create problems when applied to county statistics. Since county registration data back to 1945 were available, it was possible to calculate annual growth rates in registrations for each county using the formula:

$$\text{Annual Growth Rate} = e^{1/5 \ln}\left(\frac{\text{1978 vehicle population}}{\text{1973 vehicle population}}\right)$$

The growth rates, in percent per year, are shown in Table 6. It can be seen from this table that although some counties, such as Brown and Dane, have experienced growth rates at or near the 3 percent level, other counties such as Milwaukee, have growth rates significantly less, or, like Ozaukee and Waukesha, have growth rates significantly greater than 3 percent. As a result, applying these county growth rates to their 1978 inspectable vehicle populations yields 1982 and 1987 estimates which are somewhat different from those derived with the constant 3 percent method. The 1987 inspectable vehicle populations derived using both methods are presented in Table 7.

TABLE 6. ANNUAL GROWTH RATE, INSPECTABLE VEHICLE POPULATION, 1973 TO 1978

County	Annual growth rate, %
Brown	3.198
Dane	2.993
Kenosha	1.695
Milwaukee	0.855
Ozaukee	4.397
Racine	1.822
Walworth	2.153
Washington	4.530
Waukesha	4.342

TABLE 7. 1987 INSPECTABLE VEHICLE POPULATION, USING TWO DIFFERENT PROJECTION METHODS

County	Method I	Method II
Brown	117,789	119,335
Dane	219,871	221,928
Kenosha	84,772	76,908
Milwaukee	638,456	523,051
Ozaukee	48,608	56,516
Racine	121,438	109,278
Walworth	50,530	46,831
Washington	56,528	66,073
Waukesha	202,836	235,399
Total	1,540,918	1,455,319

The annual capacity of a contractor (or state) operated emissions inspection lane can be calculated given the vehicle throughput time, the number of inspection hours per year, and an efficiency factor to account for equipment downtime, random arrival of vehicles, etc. If it is assumed that throughput time is 2 minutes, the facility is open for business 40 hours per week, 52 weeks per year, and the facility operates at 67 percent of its total potential efficiency, then the annual capacity of an inspection lane is:

$$\left(\frac{60 \text{ min/hr}}{2 \text{ min/inspection}}\right) (40 \text{ hr/wk}) \ (52 \text{ wk/yr}) \ (0.67) = 41{,}808 \text{ inspections/yr}$$

Due to the fact that the inspection cut points will be set such that 20 percent of those vehicles inspected will fail and require reinspection, the total number of inspections performed in 1987 will be 1.2 times the figures reported in Table 7. Table 8 shows the total number of inspections required in each of the nine counties in 1987 using both projection methods. Dividing these totals by 41,808, the annual capacity of an inspection lane yields the total number of lanes required in each county in 1987, the design capacity of the system. In only two out of the nine counties, Milwaukee and Waukesha, will the number of lanes required differ between the two projection methods. In both cases the Method II projection is preferable, since it more accurately reflects historical trends ignored by Method I. Milwaukee's vehicle population has been growing much slower than the 3 percent statewide average, and Waukesha's vehicle population has been growing much faster than average. Human population statistics and projections also bear out these trends.

TABLE 8. INSPECTIONS REQUIRED, 1987

County	Method I	Method II
Brown	141,300	143,200
Dane	263,800	266,300
Kenosha	101,700	92,300
Milwaukee	766,100	627,700
Ozaukee	58,300	67,800
Racine	145,700	131,100
Walworth	60,600	56,200
Washington	67,800	79,300
Waukesha	243,400	282,500
Total	1,848,700	1,746,400

Table 9 shows the number of lanes required in each county to handle projected 1987 inspection demands.

TABLE 9. INSPECTION LANES REQUIRED, 1987

County	Lanes required, 1987
Brown	4
Dane	7
Kenosha	3
Milwaukee	15
Ozaukee	2
Racine	4
Walworth	2
Washington	2
Waukesha	7
Total	46

In locating the inspection facilities, the following methodology was used: first, due to the problems associated with locating suitable large parcels, maximum facility size was limited to six lanes; second, due to diseconomies of scale of one-lane facilities, minimum facility size was set at two lanes; third, the facilities were located in or near the population centers of their respective counties to maximize consumer convenience. Given these three site selection criteria, Table 10 shows facility configurations and general site locations.

For purposes of cost analysis, it is useful to calculate the average vehicle population inspected between 1982 and 1987. Table 10a shows the number of inspections required in each year (using Method II) and the average for the 5-year period.

PERSONNEL REQUIREMENTS

The personnel requirements for the entire program can be described in terms of either operating personnel (i.e., those directly involved in or supporting the inspection process), and program administrative personnel (i.e., administrators, legal council, accounting personnel, other indirect support personnel, etc.). The requirements for both types of personnel are discussed separately in the following paragraphs.

Operating Personnel

Based on both an analysis of the tasks involved in conducting the actual emissions test, and the experiences of the I/M programs currently in operation,

TABLE 10. INSPECTION NETWORK

County	Facility	Location
Brown	4-lane	Green Bay
Dane	4-lane	Madison
	3-lane	Madison
Kenosha	3-lane	Kenosha
Milwaukee	6-lane	Milwaukee
	6-lane	Milwaukee
	3-lane	Greenfield
Ozaukee	2-lane	Meguon
Racine	4-lane	Racine
Walworth	2-lane	Elkhorn
Washington	2-lane	West Bend
Waukesha	4-lane	Brookfield
	3-lane	Waukesha
Total	46 lanes, 13 facilities	

Table 10a. INSPECTIONS REQUIRED 1982 TO 1987

Year	Inspections required
1982	1,296,000
1983	1,327,000
1984	1,358,000
1985	1,389,000
1986	1,422,000
1987	1,455,000
Average	1,375,000

the basic personnel requirements for the test facility operation was derived. The general requirements are for:

- one manager and one assistant manager for each test facility;
- three inspectors for each test lane; and
- one maintenance/calibration person for every 10 lanes

Applying these to the network requirements shown in Table 10 results in the operating personnel requirement shown in Table 11. These requirements are identical for both the state-run and the contractor-run option.

Administrative Personnel

The following paragraphs provide a description of a proposed administrative structure that could be utilized for the program being assessed here. The structure described here is based both on an analysis of specific tasks and responsiblities associated with implementing and operating the program, and on information concerning other I/M programs that are currently in operation. While most of the personnel described in this section would be employed directly by the state, it is not likely that all positions would require new personnel; rather, it is likely that existing personnel could assume some of the responsibilities.

The basic administrative structure is shown in Figures 8 and 9 for the state-run option, respectively. As can be seen for either figure, the overall structure is organized under a Department Secretary (most likely the Secretary of either the Department of Transportation or of Natural Resources) who would hold ultimate responsibility for the program. Reporting to the Secretary would be the Program Administrator, who would be responsible for operating the program in accordance with administrative rules set by the Departments of Transportation and Natural Resources.

An advisary Task Force comprised of members of all departments directly involved in the program would provide technical imput to the Director. These individuals would be concerned with issues such as setting standards, defining exemptions, advising on policy matters, etc. Also, the responsibility for monitoring the effectiveness of the program would be delegated to the Task Force.

The Administrator would also be supported by an Engineering Coordinator and a Legal Advisor. The Engineering Coordinator would be responsible for overseeing the design and construction of inspection facilities and the selection and purchase of equipment. This would not be a permanent position; however, the position would be required only during the design and construction phase of the program startup. The Legal Advisor would not be a full-time position although it is conceivable that there would be an occasional need for these services. In all likelihood, this position would be filled from existing resources within the state government. The function of the Legal Advisor would be to advise the Administrator and the Task Force on all matters concerning the legal aspects of the program.

Table 11. OPERATING PERSONNEL REQUIREMENTS

Position	Number of individuals required per lane or facility	Number of lanes - facilities	Number of persons required
Facility manager	1 per facility	13 facilities	13
Assistant manager	1 per facility	13 facilities	13
Emissions inspector	3 per lane	46 lanes	138
Maintenance/calibration persons	1 per 10 lanes	46 lanes	5

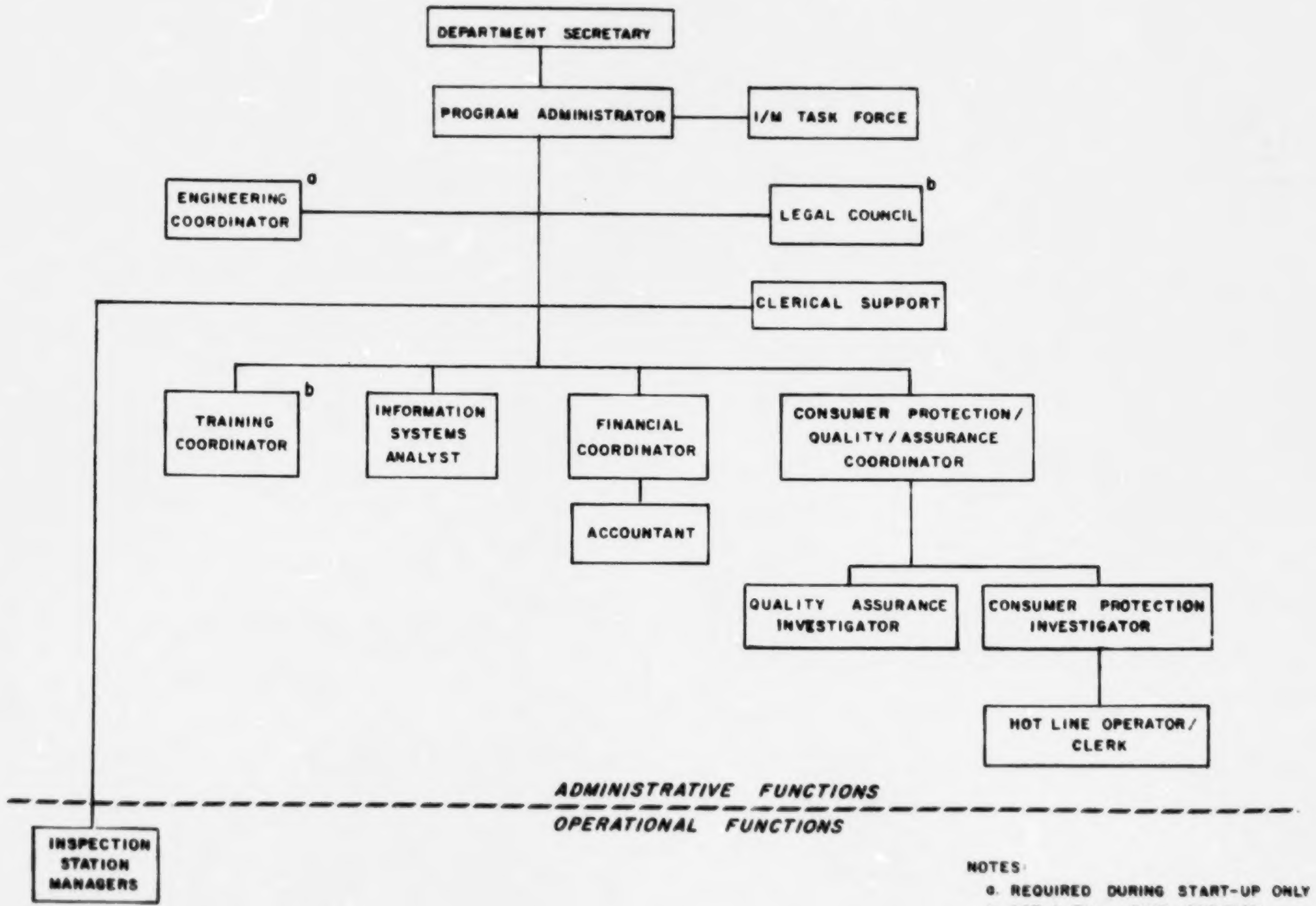
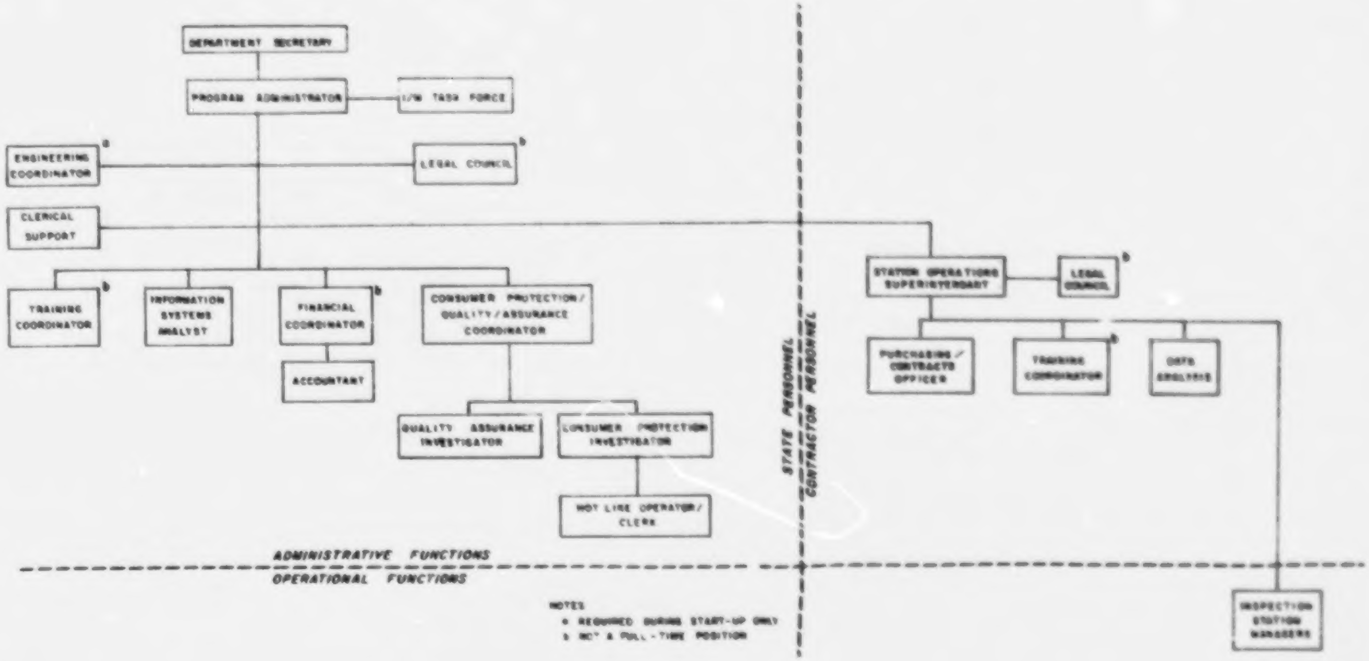

DEPARTMENT SECRETARY
PROGRAM ADMINISTRATOR
I/M TASK FORCE
ENGINEERING COORDINATOR a
LEGAL COUNCIL b
CLERICAL SUPPORT
TRAINING COORDINATOR b
INFORMATION SYSTEMS ANALYST
FINANCIAL COORDINATOR
ACCOUNTANT
CONSUMER PROTECTION / QUALITY / ASSURANCE COORDINATOR
QUALITY ASSURANCE INVESTIGATOR
CONSUMER PROTECTION INVESTIGATOR
HOT LINE OPERATOR / CLERK
ADMINISTRATIVE FUNCTIONS
OPERATIONAL FUNCTIONS
INSPECTION STATION MANAGERS
NOTES:
a. REQUIRED DURING START-UP ONLY
b. NOT A FULL-TIME POSITION

Figure 8. Suggested administrative structure for the state-run option.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PROGRAM ADMINISTRATOR
I/M TASK FORCE
ENGINEERING COORDINATOR a
LEGAL COUNCIL b
CLERICAL SUPPORT
TRAINING COORDINATOR b
INFORMATION SYSTEMS ANALYST
FINANCIAL COORDINATOR b
ACCOUNTANT
CONSUMER PROTECTION/ QUALITY/ASSURANCE COORDINATOR
QUALITY ASSURANCE INVESTIGATOR
CONSUMER PROTECTION INVESTIGATOR
HOT LINE OPERATOR/ CLERK
STATE PERSONNEL
CONTRACTOR PERSONNEL
STATION OPERATIONS SUPERINTENDANT
LEGAL COUNCIL b
PURCHASING/ CONTRACTS OFFICER
TRAINING COORDINATOR b
DATA ANALYSIS
INSPECTION STATION MANAGERS
ADMINISTRATIVE FUNCTIONS
OPERATIONAL FUNCTIONS
NOTES
a REQUIRED DURING START-UP ONLY
b NOT A FULL-TIME POSITION

Figure 9. Suggested administrative structure for the contractor-run option.

The Training Coordinator would be responsible for establishing and implementing training programs for both mechanics and personnel involved in the inspection program (except contractor personnel). This position would not require full-time effort; rather, an occasional effort would be needed both during program startup and during the actual operation of the program.

An Information Systems Analyst would be responsible for developing the software to be used in the overall data collection system and for providing periodic summaries concerning the program operation (e.g., percent failures, emission characteristics of vehicles tested, etc.) as requested by the Administrator or others. Also, he would be responsible for the day-to-day data processing effort.

Overall responsibility for the program finances would be held by the Financial Coordinator. For the state-run option, this position would be a full-time and would be supported by an Accountant. For the contractor-run option, the Financial Coordinator would not be a full-time position, and there would not be a need for the Accountant position.

A full-time Consumer Protection/Quality Assurance Coordinator would be required to administer the quality control and consumer protection aspects of the program. Subordinate to the Coordinator would be two Investigators, one for quality assurance and one for consumer protection, and a Hot-Line Operator.

The contractor-run option would require a slightly different organizational structure as shown in Figure 7. The primary difference is that several additional personnel would be required, but these would be involved individuals hired by and working directly for the contractor rather than being state personnel.

The administrative personnel requirements are summarized for both the state-run and contractor-run options in Table 12. This table indicates the number of positions and the approximate level of activity during both program startup and operation associated with each option. Again, this is a suggested structure and should be viewed as such. It does, however, reflect the desire to minimize the number of personnel involved in administrating the program, and in this context reflects the minimum personnel requirements; the impact of minimizing the program staffing is discussed in the following section.

TABLE 12. ADMINISTRATIVE PERSONNEL REQUIREMENTS FOR STATE-RUN AND CONTRACTOR-RUN OPTIONS

Position	State-run option[*]		Contractor-run option[†]	
	Startup phase	Operational phase	Startup phase	Operational phase
Administrator	1 full-time	1 full-time	1 full-time	1 full-time
Training Coordinator	1 half-time	1 half-time	1 full-time	1 half-time
Legal Advisor	1 quarter-time	1 occasionally[‡]	1 quarter-time	1 occasionally[‡]
Engineering Coordinator	1 three-quarter time	no requirement	1 half-time	no requirement
Data Systems Analyst	1 occasionally[‡]	1 full-time	1 occasionally[‡]	1 half-time
Financial Coordinator	1 full-time	1 full-time	1 half-time	1 half-time
Accountant	1 quarter-time	1 full-time	no requirement	no requirement
Consumer Protection/ Quality Assurance Coordinator	1 half-time	1 full-time	1 half-time	1 full-time
Consumer Protection Investigator	1 occasionally[‡]	1 full-time	1 occasionally[‡]	1 full-time
Quality Assurance Investigator	1 occasionally[‡]	1 full-time	1 occasionally[‡]	1 full-time
Hot Line Operator/Clerk	no requirement	1 full-time	no requirement	1 full-time
Clerical	2 full-time	2 full-time	1 full-time	1 full-time
Station Operations Superintendent[§]	-	-	1 full-time	1 full-time
Legal Advisor[§]	-	-	1 half-time	1 occasionally[‡]
Purchasing/Contracts Officer[§]	-	-	1 full-time	1 full-time
Engineer Analyst[§]	-	-	1 full-time	1 full-time
Inspector Training Coordinator[§]	-	-	1 occasionally[‡]	no requirement
Clerical[§]	-	-	1 full-time	1 full-time

[*] All personnel would be employed by the state.

[†] All personnel would be employed by the state except those in positions denoted with .

[‡] Indicates less than quarter-time.

[§] Personnel would be employed by the private contractor.

SECTION 5

ADJUNCTIVE PROGRAMS

INTRODUCTION

This section describes the adjunctive or basic support program elements. It includes quality assurance, mechanic training, consumer protection, public convenience, mechanic training, enforcement and public relations. What they have in common is that they all enhance the effectiveness of the I/M program. This includes the following functions:

- quality assurance increases the quality and uniformity of the emission inspection and repair process
- mechanic training increases the quality of the emission repairs
- consumer protection protects the consumer from unneeded repairs or inequities in the testing
- public convenience mimimizes travel time and waiting at the inspection lanes
- enforcement ensures a maximally effective system to ensure compliance
- public relations provides comprehensive information to the public on the needs, benefits, and procedures of the I/M program

It is important to realize that these adjunctive programs interrelate and overlap to a high degree. Some of the adjunctive program elements may serve multiple purposes. For example, mechanics training serves to increase the quality control of the repair or maintenance phase of the program, serves as an important consumer protection element by encouraging more uniform, less expensive emission tuneups and also may serve as a public relations mechanism by orienting the mechanics to the purpose and benefits of the overall I/M program. Given the multiple purpose nature of many of the adjunctive programs then, there is necessarily some overlap in the discussions.

The methodology consisted of two basic elements. The first element was an analysis of the overall inspection and maintenance process in reference to each adjunctive program element. The second part was extensive research into all published sources of information on the program being investigated.

This also included contacts and visits to various I/M programs around the country, calls to various governmental agencies especially the U.S. Environmental Protection Agency which has conducted or sponsored much of the research and set the basic policy for I/M programs, and finally contacts with companies currently running I/M programs such as Hamilton Test Systems in Arizona as well as emission inspection equipment manufacturers.

CONSUMER PROTECTION

An effective consumer protection program is highly important for a successful I/M program. It is important from the point of view of protecting the public from unnecessary costs and inconveniences and equally important in securing general public acceptance and avoiding a significant buildup of adverse publicity. Among such consumer protection and convenience measures are public relations elements, although the primary aim of these elements is ensuring protection from inequities in either the inspection or the maintenance phase of the program. In this discussion, consumer protection will be dealt with first and then, consumer convenience.

Consumer protection mechanisms are generally of two types. First, there are specific active procedures set up to deal with consumer complaints as they occur. These are the consumer hot lines and complaints investigators. Second, there are features built into the system that directly or indirectly protect consumers from potential inequities or abuses. These include state motor vehicle repair regulations, repair cost ceilings, waivers or exemptions, repair facility or mechanic licensing or approval, and warranty regulations (both federal and state).

Existing Consumer Protection Mechanisms

Before discussing the specific consumer protection mechanisms to be added for the I/M program, it is important to describe the various regulations and mechanisms that already exist in Wisconsin.

Consumer complaints concerning improper, inadequate or overpriced repairs (exceeding $25.00) in any private repair facilities, except fleet repair stations, are currently handled by the Trade and Consumer Protection Division of the Department of Agriculture. The authority to regulate the repair practices of private facilities was established by the Wisconsin Administrative Code Chapter (Agriculture) 132, entitled "Motor Vehicle Repair." According to these regulations, which became effective on September 1, 1975, repair facilities are required to obtain repair orders and provide price estimates for repairs exceeding $25. They also require specific authorization for doing any work not requested by the customer. The law prohibits the repair shop from collecting for repairs not authorized by the customer, repairs known to be unnecessary, or repairs that should not have been made. Also, the shop is required to keep detailed records of repairs made, charges, parts used, etc. This law, if enforced properly, would clearly go a long way towards providing the consumer protection needed in an I/M program.

The Department of Transportation, Dealer Inspection Unit, handles complaints for new and used motor vehicle sales. Automobile sales through dealers are regulated by Wisconsin Administrative Codes, Chapter MVD 24, Motor Vehicle Trade Practices. According to this law, new car dealers must furnish to the customer prior to the delivery of any new motor vehicle a copy of the predelivery test and inspection made pursuant to the manufacturer's specifications. The law also requires that all used car dealers specify in writing prior to sales all significant existing mechanical and structural defects.* Such regulations would give the consumer better knowledge prior to purchase as to whether the car will require extensive repairs. Finally, this statute also requires that prior to sale, all existing warranty provisions for new and used cars be brought to the attention of the purchaser. This provision would help in the implementation of the Federal 207(b) warranty on emission controls, which is discussed below in the Warranty section.

Consumer Hotlines

Consumer hotlines would serve two important functions. First, they would provide valuable information to the public regarding basic operating times and locations of the inspection lanes, procedures, consumer rights and obligations, and other related information. Second, and equally important, the hotlines would be centralized referral points to guide the consumer after an evaluation of his problem to the correct department. In many cases, all that may be needed is correct information, but when a significant problem requires the attention of a particular department, the consumer can then be routed to the right office. Also, the hot line personnel are trained in dealing with the public and thus can make a significant contribution to the overall public relations effort of the overall I/M program. It is very important that all contacts between the public and I/M personnel be smooth and harmonious, especially given the somewhat controversial nature of the program. In Wisconsin, the hotlines themselves would likely be manned by the Department of Transportation.

Complaints Investigation

Some of the problems reported to the hotlines operated by the Department of Transportation would require referral to other departments, depending on the nature of the complaint. As an example, complaints that require legal actions would be routed to the Attorney General's office. Of course some problems would presumably involve more than one department's involvement. Any problem could potentially involve the Attorney General's office at some point if illegal proceedings were uncovered that required legal action or resolution. Hopefully, most problems could be resolved without resort to legal action. The types of problems and organization in the appropriate department are discussed below.

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*Among the items requiring disclosure prior to sale are the emissions and exhaust and fuel systems.

Complaints Regarding Centralized Inspection Lanes--

The Department of Transportation would handle complaints regarding the inspection process conducted by the state or contractor in the centralized inspection lanes. The Quality Assurance Investigator would visit the contractor (or state) inspection stations at least every 90 days or at random intervals. Presumably the investigator would check any stations or individual analyzers that are giving undue numbers of passes or failures.

Complaints Regarding the Repair Industry--

As indicated above, the Department of Agriculture currently has regulations governing the repair of motor vehicles. The Department's Trade and Consumer Protection Section would likely continue in its function of assuring that correct procedures are followed regarding repair orders, repair price information, estimates, and repair authorization. These procedures would play an important role in keeping the repairs within reasonable cost limits and protecting the consumer from unnecessary repairs. Investigations of specific complaints in repair shops would be conducted by the Consumer Protection Investigator.

Attorney General's Office--

The Wisconsin Attorney General's office would not be involved in most complaints. The Attorney General's office would become involved in prosecution of more serious cases of consumer fraud or when there were repair facilities that had serious and continued records of violations of the regulation governing motor vehicle repairs, emission inspections, or tampering.

Repair Costs Limits

The repair cost limit is a maximum cost that a motorist may be obligated to spend on repairs for his motor vehicle in order to meet the emission standards. This cost ceiling helps to prevent the program from becoming an excessive burden on those vehicle owners in lower income brackets especially. Also, on certain vehicles the cost of complying may be so great as to make operation prohibitively expensive. However, it should be clearly stated that the vehicle owner is in no way compelled to keep the repairs below the specified limit. For those who can easily afford the extra costs or who desire to achieve full compliance, there should be strong encouragement to do so.

Repair costs may be cumulative. In some cases a motorist may fail the retest and return to the repair shop again for repairs. The repair cost limit applies to the cumulative emission repairs for the entire sequence within a specified time limit after failing the emission test.

Repair cost limits are generally of two types. First, an absolute dollar limit and second, a sliding scale related to the value of the vehicle. In the first approach generally a fixed upper limit of from $50 to $100 is set which applies to all vehicles regardless of their age, conditions, or resale value. In the second approach, which in theory would be more equitable, the price ceiling relates to the vehicle value as determined by an accepted reference such as the used car Blue Book of average retail prices. The Minnesota I/M revised statute, Section 5, reads as follows:

> "Maximum Repair Cost. 1(a) The maximum repair cost for meeting emission standards, not covered by any warranty, shall be as follows: a motor vehicle having a value of $2,000 or less, $50, for each full $500 of vehicle value over $2,000, an additional $10. Motor vehicle values shall be determined as provided in Minnesota Statutes, Section 168-013."

Wisconsin has tentatively selected a $50 repair cost limit. The data shown in Table 13 indicate that this limit would cover 80 to 90 percent of the average repair costs. If the repair cost limit is specified in the legislation it should allow for periodic revision to reflect the average repair costs actually experienced in the Wisconsin I/M program plus the effect of inflation.

Waivers and Exemptions

Granting of waivers or exemptions for specific vehicle types, in addition to vehicles exceeding the repair cost ceiling, is another consumer protection mechanism. Wisconsin has tentatively chosen to exempt vehicles older than 15 years and experimental vehicles. Exemptions of vehicles over a certain age is a commonly used method to protect owners from undue financial hardships. The older vehicles generally cost more to bring into compliance and are more likely to need extensive repairs such as ring or valve jobs. Moreover, given the small fraction of the total vehicle population that they represent, such exemptions entail a minimum sacrifice in overall emission reduction benefits. Other vehicle types commonly given exemptions are electric, experimental, antique, and off-the-road vehicles. The major considerations when judging whether any particular vehicle type should be exempt would be the potential hardships on vehicle owners, balanced by effects on overall emission reductions.

Licensing, Certification, or Approval of Repair Facilities and Mechanics

Licensing or certification of repair shops and mechanics are mechanisms for ensuring that repairs are done adequately and at a reasonable cost to the consumer. As such, they may be important as consumer protection elements. The type and degree of regulation of private industries such as repair shops by state government is a sensitive issue but given the need to ensure protection of the consumer and the adequacy of repair, some type of interaction or influence on repair industry practices is crucial. An active mechanic training program in emission-related tuneup and emission repairs has been shown to have a very beneficial impact on upgrading mechanic skills and fostering a positive attitude toward emission control. Mechanic training will be discussed later in this section.

Most states and repair industry groups do not look favorably at formal licensing of repair shops and mechanics; rather, they view it as expensive interference in private industry. Of course, when the repair facilities are designated as official inspection stations then some sort of official licensing and close supervision is very important for both consumer protection and quality assurance considerations. However, in the centralized state and contractor approaches being considered in Wisconsin, the same degree of state supervision is less critical. Generally there are two reasons for needing some supervision

TABLE 13. I/M REPAIR COSTS

New Jersey

Less than $10	29.7%
$10 - $25	26.4%
$25 - $50	22.1%
$50 - $100	16.1%
Over - $100	5.6%

N = 16,000
Average repair costs = $32.40
Median - 50% of repairs cost less than $20
65% of repairs cost less than the average

Oregon

No cost	27%
$0 - $10	37%
$10 - $30	18%
$30 - $50	8%
$50 - $75	5%
Over $100	2%

N = 1400 (primarily newer cars)
Average repair costs = $16.00
Median - 50% of repairs cost less than $8
71% of repairs cost less than the average

Arizona

Less than $5	27%
$5 - $10	17%
$10 - $25	24%
$25 - $50	20%
$50 - $100	10%
Over $100	2%

N = 2000
Average repair cost = $23.40
Median - 50% of repairs cost less than $15
64% of repairs cost less than average

Failure rates - New Jersey - 12% (annual)
Arizona - 16% (annual)
Oregon - 36% (biannual)

or influence on the private repair facilities: emission analyzer calibration and accuracy and control of unauthorized repair practices. Rather than formal licensing of repair facilities, by which is meant that only licensed facilities could perform emission repairs, a lesser degree of control in the form of certification or approval would be appropriate. Given the need for using reasonably accurate and reliable analyzers, many states publish lists of approved emission analyzers. New Jersey has one such list. A repair facility may become approved or certified if it utilized an approved analyzer. In addition, the state may require that the facility employ emission tuneup mechanics who have taken approved mechanic training courses. Furthermore, the state could have each approved analyzer calibrated at regular intervals.

The I/M Task Force has indicated that it is reluctant to endorse further State regulation of the auto repair industry at this time, therefore, a certification program is currently not being considered. It is recommended here, however, that consideration be given to at least a minimal program consisting of very elemental components that, in the aggregate, serve more to provide incentives to the repair industry rather than place controls on it. A minimum program would include recognizing repair facilities that employ mechanics who have completed the State mechanic's training program and also are equipped with a suitable exhaust analyzer. Recognition could, for instance, be merely distributing lists of these repair facilities to motorists who fail the emission inspection and therefore will need to have repair work done. Obviously, it would be to the advantage of a repair facility to be included on the list, therefore an incentive would exist for not only participating in a training program, but for ensuring that reasonable repair work is being performed as well.*

WARRANTY PROTECTION

In Wisconsin consumers would be protected by both state and federal warranty programs. Prospective buyers of new and used vehicles are protected under Wisconsin Administrative Code MVD 24, Motor Vehicle Trade Practices with respect to warranties in the following manner: the dealer must provide for each used vehicle the basic terms and conditions of warranty, if offered, displayed in a conspicuous place; if the sale of a motor vehicle is made subject to a warranty, such warranty must be in writing and must be provided to the buyer prior to or at the time of purchase and must include all the basic information on the terms, coverage, and exclusions of the warranty; it is an unfair practice and prohibited for a warrantor to fail to service or repair a motor vehicle in accordance with the terms and conditions of the warranty or service agreement. The enforcement of these warranty provisions is handled by the Department of Transportation, Dealer Inspection unit. The enforcement of these provisions is especially important in view of the possibility of the failure of emission control equipment such as the catalytic convertors whose replacement could become a significant burden on the public, if unregulated through warranties. Also, since the ability of in-use vehicles to maintain the emission standards for which they were designed depends largely on the integrity of the catalytic converters it is significant to have a mechanism that ensures that failed equipment will be identified and replaced. This problem was recognized by the Clean Air Act Amendments warranty provisions in Section 207(b).

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*This presupposes that an additional consideration as to whether or not a particular service facility would be listed is the quality of repairs and integrity of the business as judged by reinspection results and feedback from consumers through complaints.

The intent of the Federal Clean Air Act 207(b) warranty provisions was to ensure that the basic emission control equipment be manufactured such that it would last up to 50,000 miles or 5 years, whichever came first. As such 207(b) may be seen as an incentive to the manufacturers to design the basic emission control equipment to last at least up to the end of the warranty period if not longer. There is still much debate about what should be the best warranty period and suggestions have been made to have the warranty extended to the entire useful life of the vehicle or 100,000 miles. The actual wording of section 207(b) is as follows:

> "(b)If the Administrator determines that (i) there are available testing methods and procedures to ascertain whether, when in actual use throughout its useful life (as determined under section 202(d), each vehicle and engine to which regulations under section 202 apply complies with the emission standards of such regulations, (ii) such methods and procedures are in accordance with good engineering practices, and (iii) such methods and procedures are reasonably capable of being correlated with tests conducted under section 206(a)(1), then—
>
> (1) he shall establish such methods and procedures by regulation, and
>
> (2) at such time as he determines that inspection facilities or equipment are available for purposes of carrying out testing methods and procedures established under paragraph (1), he shall prescribe regulations which shall require manufacturers to warrant the emission control device or system of each new motor vehicle or new motor vehicle engine to which a regulation under section 202 applies and which is manufactured in a model year beginning after the Administrator first prescribes warranty regulations under this paragraph. The warranty under such regulations shall run to the ultimate purchaser and each subsequent purchaser and shall provide that if—
>
> (A) the vehicle or engine is maintained and operated in accordance with instructions under subsection (c)(3),
>
> (B) it fails to conform at any time during its useful life (as determined under section 202(d)) to the regulations prescribed under section 202, and

> (C) such nonconformity results in the ultimate purchaser (or any subsequent purchaser) of such vehicle or engine having to bear any penalty or other sanction (including the denial of the right to use such vehicle or engine) under State or Federal law,
>
> then such manufacturer shall remedy such nonconformity under such warranty with the cost thereof to be borne by the manufacturer. No such warranty shall be invalid on the basis of any part used in the maintenance or repair of a vehicle or engine if such part was certified as provided under subsection (a)(2). For purposes of the warranty under this subsection, for the period after twenty-four months or twenty-four thousand miles (whichever first occurs) the term "emission control device or system" means a catalytic converter, thermal reactor, or other component installed on or in a vehicle for the sole or primary purpose of reducing vehicle emissions. Such terms shall not include those vehicle components which were in general use prior to model year 1968."

The basic meaning of the warranty is that the manufacturer will be responsible for the costs of replacement of the emission control devices or system up to 50,000 miles or 5 years whichever comes first provided that the vehicle is operated and maintained in accord with written instructions furnished by the manufacturer. In relation to the I/M program, what is particularly important is the definition of the acceptable test procedures referred to in the first paragraph of section 207(b). The basic question is what actual emissions test will be reasonably correlated with the basic standard of emission testing which is the Federal Test Procedure (FTP) used to determine if prototype vehicles and vehicles selected from the assembly line meet the applicable emission test standards under the Federal Motor Vehicle Emission Control Program (FMVCP). The purpose of this program is to ensure that cars being designed and manufactured meet the Federal emission standards. 207(b) requires that there be a reasonable correlation between the short emission test used in the I/M program with the lengthy FTP. To date five short test have been proposed as suitable for use in light-duty vehicle and light-duty truck emission inspection program. These include the following tests:

- the idle test
- the Federal 3 mode
- the Clayton Key mode
- the Federal Short Cycle
- the New York/New Jersey short cycle

These tests, then, have been proposed as being suitable for use in an I/M program to implement the warranty provisions of 207(b). An associated issue is the determination of appropriate cutpoints, that is, correct emission test standards. There are three options for developing these standards: states can determine them, or they can be provided by EPA or the manufacturers could provide the data on the basis of which standards would be set either by the states or the EPA. With EPA's adoption of official cutpoints, however, in order for the 207(b) warranty provisions to be activated by an I/M program test failure, then the state's I/M cutpoints must be at least as stringent as the promulgated EPA cutpoints. EPA has not yet officially promulgated the cutpoints.

PUBLIC CONVENIENCE

The general motoring public is likely to view Inspection/Maintenance as an inconvenience, as yet another requirement imposed by the state. Without properly designed public relations programs, I/M is likely to be very unpopular. In Arizona, the program was very nearly defeated in a public referendum for this very reason. As a result, an I/M program must be designed so as to be as convenient as possible to the motoring public. There are tradeoffs, however, between public convenience and program cost, which is ultimately reflected in inspection fees. Consumer convenience can be promoted in a variety of different ways, among which are the following:

1. Contractor (or state) facilities should be placed in locations which maximize their accessibility to the public. Stations should be sited in or near maximum concentrations of population, so as to minimize the travel distance between the average vehicle owner and the inspection facility. In no case should a motorist have to spend more than 20 to 30 minutes traveling to an inspection facility.

2. Waiting lines in contractor (or state) inspection facilities should be kept to a minimum through automation of test procedures and proper design and sizing of facilities such that their capacity is sufficient to handle peak demands. Registration mailings can also be timed so as to stagger the number of inspections processed within a given month, so that vehicles do not arrive at the inspection stations in large numbers at the end of their registration period. If necessary, inspections could be assigned on an appointment basis to ensure that vehicles arrived at stations on off-peak hours. At present, the registration process is arranged, such that 8 to 10 percent of total registrations are processed each month with the exception of January, where about half that number are processed. This system would seem adequate to spread inspections fairly evenly throughout the year; however, they may well need to be spread out evenly throughout the month as well to avoid bunching and long waiting lines at the end of each month.

3. Retest policies for those vehicles that fail inspection can take a variety of different forms, some of which are more convenient from a consumer viewpoint than others. The maintenance - retest cycle can be made either a two-stop or a one-stop procedure. In the two-stop procedure, a motorist would be given a certain time generally between 30 to 80 days, in which to have his vehicle maintained, and then would be required to

bring it back to the contractor (or state) inspection station for a free retest before the registration process could be completed. In the one-step procedure, such as that used in California, a motorist whose vehicle failed inspection could be required to bring the vehicle to a certified repair facility containing a state-approved and calibrated analyzer. At this facility, the vehicle would be maintained and retested. If its emissions were corrected to meet the standards, the owner would be given a certificate of compliance directly by the repair facility and would not be required to undergo the free retest at the contractor (or state) facility.

Both of the above retest policies have advantages and disadvantages. The one-stop policy obviously involves less travel time and waiting time on the part of the vehicle owner, but it also involves a widespread state program for licensing, certifying, and regularly calibrating emissions analyzers in private repair facilities. The manpower and equipment costs involved in such a program might be so high as to significantly affect the test fee. If this is the case, then serious equity considerations arise: should the entire motoring public be made responsible for a program that benefits only those vehicles that fail? Contractor (or state) facilities have been designed and costed so as to have sufficient capacity to handle retests, and these retests could be performed in these facilities in a much more rigorously controlled test procedure than in private repair shops.

PUBLIC RELATIONS PROGRAM

Experiences in several states that recently established inspection/maintenance programs emphasize the importance of an effective public relations program. A well-designed, comprehensive program that introduces the public to the basic need for, and benefits of, I/M and clarifies the misunderstandings that surround I/M is critical during the early stages of implementation. A well-thought-out program can help eliminate potentially adverse reactions that other states with inadequate public relations programs have experienced (e.g., Arizona; Cincinnati, Ohio; and Chicago).

A comprehensive public relations program should consist of three basic phases: (1) early initial public education on the basic need and benefits of I/M; (2) an intensive public relationship effort 6 months prior to the actual beginning of mandatory inspection; and (3) an ongoing public relations program.

Phase I: Initial Public Information Program

The emphasis of this phase, which should begin in the early planning and design stages, should be in basic education as to the needs for I/M, the benefits of I/M, and what it means to the public. It is very useful that the public begin to gain a familiarity with the I/M concept and that this concept have time to grow in the public awareness. By beginning early grass roots activities, support for the I/M program can be obtained. The elements of this phase would consist of a slide presentation, mobile emission testing display, a generalized brochure, and press releases. The slide presentation can be given to specialized interest groups such as clean air groups, environmental groups and conservation clubs, the League of Women Voters, automobile clubs, automobile service industry groups, and local civic or service clubs. Also, metropolitan and regional planning agencies can be involved at this point. A mobile emissions test demonstration van has been found useful to acquaint the public or special groups with the inspection process. Many states have prepared brochures explaining I/M and distributed it widely among the general public. As important decisions are made and implementation begins, periodic press releases should be made. This initial public information effort may be accomplished by the state itself or through assistance provided by private organizations with experience in I/M public relations programs. Some states have contracted with the local clean air or lung association.

Phase II: Preinspection Public Relations

About 6 months prior to the opening of test lanes for mandatory testing with voluntary maintenance, there should be an intensive public relations effort. During this time every motorist must be informed of the needs and benefits of I/M and also of his obligations and rights and the basic organization and procedures in the program. Also, this is the period during which the training of the inspectors, in either state or contractor lanes would occur. An important part of the training is dealing effectively and courteously with the public.

The basic elements of Phase II public relations would be a mailing to each motorist, inspector training, news relations and media advertizing. The mailing would consist of a pamphlet not only explaining the basic reasons for having I/M and the benefits such as air quality and fuel economy improvements but also what the times and places of the inspection stations operation, what consumer rights and obligations are, what the complaint procedures are, and also important details of the maintenance phase. During this phase, media advertisements or announcements are important because it is critical that every affected motorist receives the right information. All the employees of both the state and the contractor who deal directly with the public especially the emission inspectors, station managers, hot line operators, complaints investigators, and calibration officials should receive training in how to deal with the public and an understanding of the basics of I/M.

Phase III: Ongoing Public Relations

The emphasis in the ongoing public relations program is largely informational. States with existing I/M programs such as New Jersey and Arizona have indicated that as the public becomes used to the program there may be somewhat less need for an intensive public relations effort. There would still be a need to inform motorists of any significant changes in program operations or other modifications of program elements such as waivers, exemptions, repair cost ceiling, inspection fees, or registration procedures. This would entail periodic mailing and possibly some media announcements. Also, new employees who deal with the public would be required to receive the same orientation that the initial personnel received at the beginning of the program. The public should also be made aware of the status of the program in terms of the emissions reductions achieved.

QUALITY ASSURANCE

Maintaining a high degree of precision and uniformity in emission test results is vital to the success of an inspection/maintenance program. Accurate information must be generated to correctly analyze the impact of the program on lowering emissions and to maintain public interest in the program. If I/M is perceived as a haphazard, arbitrary program, enforcement problems will become intractable.

The repeatability of the actual test results is central to the issue of quality assurance. The test must be carried out correctly and with a high degree of uniformity on all vehicles included in the program. Wisconsin's decision to establish a state- or contractor-operated network of test lanes will facilitate the standardization and repeatability of tests. Such a system contains a relatively small number of high quality exhaust gas emission analyzers that can be closely monitored.

It is technically feasible and desirable to automate the testing sequence in this situation, tying all operations associated with the test into a central computer system.

The key or loaded-mode test procedure that Wisconsin has chosen to incorporate into its I/M program is a sophisticated test that measures vehicle exhaust emissions under a variety of different "loads" or conditions that simulate the actual emissions generated by a vehicle under normal driving conditions. To correctly perform a loaded-mode test, a series of samples must be taken from a vehicles exhaust when it is experiencing loads within certain parameters. The results of this sampling series are integrated to provide a composite assessment of the vehicle's emissions characteristics.

Automating a loaded-mode test by interfacing the control of the analyzer and dynamometer with a computer routine removes a large portion of the cause of test result variability, human error. This approach to test control limits human involvement to (1) identifying the vehicle to the computer by means of entering the vehicle identification number (VIN) into an input/output device (i.e., a "CRT" or TV screen-type computer terminal), (2) manually inserting the analyzer probe into the tailpipe (or tailpipes) of the vehicle being tested, and (3) operating the vehicle on the chassis dynamometer. The computer routine can monitor the "load" being generated by the dynamometer and automatically take exhaust samples at the appropriate times. The sample results can be integrated by the computer and compared with test standards stored in the computer.

Once such a system has been installed and its software has been found accurate and reliable, a series of relatively simple checks should be made to insure its continued correct operation. Analyzers must be calibrated periodically. This procedure is straightforward. By analyzing a set of "calibration gases" that have known precisely-blended contents and checking the analyzers readings of actual gas content, the analyzers accuracy can be determined. At the very least, an exhaust gas analyzer should be checked in this fashion whenever it is turned on and adjusted if its readings are different than they should be. With an automated system, the analyzer can be calibrated regularly at frequencies of 1 hour to minimize the possiblity of inaccuracies resulting from equipment malfunction.

If the contractor-operated system is chosen, periodic inspections should be made by the state to verify the accuracy of data submitted by the contractor. Ninety days is the generally accepted interval for such checks on central test lane equipment. In addition to scheduled inspections, the state may perform unannounced checks if there have been complaints about test accuracy or other indications that an analyzer has not been functioning properly.

In order for such state inspections and checks to be useful, there are certain informational requirements that should be placed on the contractor. Most important, periodic reports on the frequency and results of equipment calibrations should be mandatory. A log of any adjustments made in the process of calibrating equipment should also be kept. Experience to date shows that the operation of automated test systems is relatively trouble free, and that downtime resulting from equipment malfunction is minimal. In addition to direct equipment maintenance and calibration records, there are a number of items that should be recorded to provide data for use in analyzing the effectiveness of the program. This subject is dealt with in the section of this report concerned with legislative aspects of implementing I/M.

Another quality assurance issue that should be handled in program enabling legislation is the provision of a clause that prohibits the contractor from engaging in any other type of business that leads to a conflict of interest. The contractor must not be in a position to profit from one test result, but not another. This issue is discussed more completely in Section 6 which deals with enabling legislation.

Standards should be set regarding the type of analyzing equipment that may be used by the contractor. There is a wide range in the quality and capacity of such equipment on the market today. Use of equipment that is inappropriate to a centralized network type application could provide a very low level of test accuracy and uniformity between tests. Wisconsin can establish equipment performance standards in one of two fashions. First, a list of approved equipment, by manufacturer and model type can be compiled. Alternately, the actual specifications and tolerances that acceptable equipment must meet may be promulgated.

There are a number of performance parameters that should be specified to insure that only high quality equipment is used. Most obviously, the accuracy (in plus or minus percent) of the actual hydrocarbon and carbon monoxide readings must be specified. The consistency of a unit's analysis over time should also be subject to limits. If this "zero drift" is large over time, either more frequent recalibrations should be stipulated or the unit should not be approved for use. The "purge time" of an exhaust gas analyzer is another important parameter. This refers to the time interval that must pass between tests to assure that the emission readings are influenced only by the exhaust of the vehicle being tested. The "purge time" is a measure of the time that a unit must remain unused before it has been cleansed of all gases introduced by the previous test sequence. In high speed units of the type suitable for use in the high volume contractor-operated system Wisconsin has chosen, an inert or "neutral" gas such as nitrogen is run through the analyzer after each test sequence to remove all traces of material introduced into the analyzers system by previous tests.

Specifications of an analyzer that is quite adequate for the applications described here are presented in Table 14. These specifications are provided for use as a guideline in selecting analyzers and are not intended to be used as "minimum" standards. This information was obtained from Horiba Instruments Incorporated, Irvine, California.

MECHANICS TRAINING

Need for Mechanics Training

Mechanics training is a highly important part of an effective I/M program. Mechanics training may occur through a very structured government sponsored series of courses, through auto industry programs, as a regular part of vocational training courses, or informally through repair shop on-the-job training. Most government sponsored mechanics training courses include both background content, or orientation towards the basic need and benefits of I/M and the mechanic's role in the program, as well as technical content on emission systems, correct diagnosis and repair of emission systems and low emission tuneup procedures. EPA and the automotive industry have focused much attention on mechanics training for two basic reasons. One is the increasing technical complexity not only of the emissions controls but the overall technical sophistication in the basic ignition and carburetion systems, and the use of electronic devices and power systems, there is an ever accelerating need for constant training and retraining of mechanics. In recognition of this automobile manufacturers have themselves instituted in-service training programs for mechanics. The second basic reason for needing mechanics training relates to the employment situation in the automobile repair industry itself and public attitudes towards the repair industry. Due to skill shortages, relatively high employee turnover rates, the growing complexity of the motor vehicles mentioned above, and due to abuses by some car dealers and repair shops, it is generally considered that there are widespread substandard and unethical repair practices in the repair industry. In the past few years there has been much publicity on consumer dissatisfaction with the quality of service experienced throughout the repair industry. In response to this general dissatisfaction, there have been proposals to have more stringent regulation of the repair industry such as licensing or certification of repair facilities or mechanics. The potential effects of such regulations has been debated widely and most industry spokespersons oppose overly stringent controls because they appear to restrict competition.

A related development of major concern to the I/M program itself is the widespread practices of vehicle owners tampering with their emissions controls, and fuel switching. Misunderstanding on the part of both the public and the auto service industry on the technical aspects of emission controls and the relationship between emissions control, and fuel economy and performance have

TABLE 14. GENERAL SPECIFICATIONS OF A TYPICAL I/M CENTRALIZED FACILITY EMISSION ANALYZER

Item	Specifications/Comments	
Measuring Method:	NDIR, optical filter, dual source gas-filled capacitive type detector.	
Sensitivity:	0.5% of full-scale analysis range	
Repeatability:	±0.5% of full-scale with successive identical gas samples under the same physical conditions	
Zero Drift:[*]	less than 1% of full-scale/24 hrs	
Span Drift:[*]	less than 1% of full-scale/24 hrs	
Response Time (electrical):[†]	0.5 to 15.5 seconds to 90% of full-scale in 120 switch selected increments	
Ambient Operating Conditions:	temperatures between $0^{\circ}C$ to $40^{\circ}C$ humidity - less than 95% RH	
Warm-Up Time:	30 minutes to full accuracy	
Power Requirements:	115 VAC (±10%) 60 Hz ±0.5 Hz	
Meter Readout Accuracy:	5% of full scale	
Sample Gas Flow Rate:	0.5 to 10 liters per minute	
Sample Gas Inlet Pressure:	28.5 p.sig.	
Interference From Co-existing Gases:	less than 1% of full scale	
Minimum/Maximum Measuring Range:[‡]	Minimum	Maximum
CO (carbon monoxide)	50 ppm	100%
CH_4 (methane)	100 ppm	100%
C_3H_8 (propane)	100 ppm	100%
C_6H_{14} (n-hexane)	100 ppm	5%

[*] Drift performance specifications are based on ambient temperature variation of less than $10^{\circ}C$ over a 24-hour interval.

[†] Total analyzer response time is dependent on sample gas flow rate, sample cell length and electrical response time.

[‡] Minimum Recommended Measuring Range is the full-scale concentration which may be measured with a 500 mm sample cell, response time of 0.5 seconds full-scale and a noise level of less than 0.5% of full-scale.

encouraged these practices. U.S. EPA has stated that 35 percent of 1976 and 1977 model cars have had their emission systems tampered with in some way, ranging from minor adjustments away from manufacturer's specifications, to major, sophisticated disconnections or modifications.[1] At a recent emission control conference, Mort Schultz, the editor of "Car Clinic" in Popular Mechanics Magazine stated that he receives scores of letters from individual car owners asking how to disconnect their emission control equipment.[2] Twenty percent of the letters that Mr. Schultz receives deal with emission control or related problems. In many cases, auto mechanics both in small shops and dealer service organizations encouraged tampering or were unable to fix problems that related to emission control system problems. Among the solutions to these problems, according to Mr. Schultz, was "better mechanic orientation." The mechanic at the grass roots level can be the best emissary or the worst enemy. If he or she is convinced that emissions control is necessary then he or she can convince the consumer... Better Consumer Education."[3]

Benefits of Mechanics Training

The benefits of mechanics training may readily be seen from the above analysis of the need for mechanics training: better understanding of the need for emission tuneups and repairs, a more positive attitude towards emissions reduction and I/M program, higher quality emission repairs and tuneups, fewer consumer complaints about emission repairs, reductions in illegal tampering and fuel switching, and, generally, a better relationship between the auto repair industry and the public. In conjunction with mechanics training a comprehensive public education program is, of course, needed to ensure that the public at large does not encourage or contribute to unethical practices such as tampering that reduce the overall effectiveness of mechanics training programs in particular and the I/M effort in general.

Approaches to Mechanics Training

A variety of approaches have been instituted for mechanics training in various states, ranging from very comprehensive government-sponsored programs to informal industry sponsored efforts. In this discussion, the emphasis will be on providing an understanding of the range of methods that could be employed in Wisconsin.

Many states have instituted a formal, structured mechanics training program in conjuction with the implementation of their I/M programs. In terms of the actual timing of these courses, it is important to begin training mechanics several months to a year before the mandatory inspection process begins. However, the difficulty in implementing early training programs relates to the fact that attendance is voluntary. Consequently, there must be an incentive to participate. The primary incentives are, first, government requirements for the official certification of a repair shop that it employ at least one mechanic who has completed an approved mechanics training course and second, the economic incentive to the repair facilities and mechanics that result from the certification process. The repair shops that meet the certification requirements can increase their repair business and this serves as a significant incentive to other shops and mechanics to join the program. Obviously, as the I/M program becomes operational and repair demand grows, so does the demand for mechanics training. The more formal government sponsored programs are held in a classroom setting at local vocational schools or community colleges. Typically, such courses may be held in the evenings and last for 12 total hours. Subject matter includes basic orientation to the needs and benefits of I/M and the role of emission tuneup personnel in the I/M program and familiarization with basic emission control equipment and emission control tuneups. "Hands-on" experience is important. Instructors for such programs may be trained through the Colorado State University emission instructor program. These master teachers then are available to train local vocational education instructors.

Another approach to be considered which was found useful in Arizona's program, is on-the-job training. Special two-person instructor teams may hold courses at local repair facilities, training mechanics from nearby shops. This approach emphasizes practical experience and overcomes the problem of reaching mechanics who are unable to take the time off to attend classroom courses.

In addition to government sponsored I/M program mechanics training courses, it is important to consider industry sponsored efforts and resources. General Motors Training Centers are available in many metropolitan areas. These centers regularly hold special emission control repair and tuneup courses for GM equipment at no charge to the mechanics. Some dealers send mechanics regularly to these centers to update their knowledge and skills to keep abreast with the rapidly changing technologies. The other major automobile manufacturers also offer training opportunities, although not as extensive as those from GM. Manufacturers, both domestic and foreign, may send instructors to dealers or localities with mobile vans and conduct mechanics training upon request from local car dealers.

Another important resource is the statewide vocational education school system. Regular mechanics training courses of longer duration than those described above, are held for students seeking basic automobile mechanic skills. These courses should receive continuous update of the new technologies and skills so that students graduating from then are competent to do emission control repair and tuneup practices.

PROGRAM ENFORCEMENT CONSIDERATIONS

Once Wisconsin initiates an I/M program, efforts should be made to monitor the public's rate of compliance with program requirements. Steps should be taken to minimize public behavior that may adversely affect the goals of I/M. Maintaining a high level of participation in the actual inspection procedure by owners of vehicles included in the program is a prime concern. An effective enforcement effort will tend to discourage noncompliance by making it highly visible and by levying sanctions that are sufficiently severe to render noncompliance undesirable to motor vehicle owners.

Current Motor Vehicle Registration Procedures

The Bureau of Registration and Licensing (BRL) of the Wisconsin Department of Transportation's Division of Motor Vehicles registered some 3.5 to 4 million light-duty vehicles in 1977. This estimate includes both initial and renewal registrations. Vehicle registration activity occurs fairly regularly over time. The distribution of registrations by month appears below:

DISTRIBUTION OF LIGHT-DUTY VEHICLE REGISTRATIONS BY MONTH, %

July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June
9.3	10.2	8.8	7.7	7.8	6.2	6.5	6.5	11	7.7	7.5	10.7

Initial registrations may be made in person by motor vehicle owners at one of 22 or more BRL offices scattered across Wisconsin. Applications made before the 16th of any month result in issuance of a registration that is valid from the first of the month. Applications made on or after the 16th of any month produce registrations that become valid on the first of the following month. In both cases registrations issued are valid for 12 months.

Roughly 30 days prior to the expiration of a motor vehicle registration, the BRL mails renewal forms to owners of all motor vehicles with valid registrations. Motorists then return completed renewal forms by mail to the BRL. If the motorist desires, this process may be completed in person.

Registration Related Enforcement Procedures

Maintaining a high participation rate in the I/M program assures that the program's emission reduction goals will not be jeopardized. Also, from an equity standpoint, full participation by all owners of vehicles covered by such a program is necessary. The most effective method of enforcement, based on the experiences of programs in other states, is to make I/M compliance a requirement for registration and reregistration of motor vehicles. Recent policy statements made by U.S. EPA indicate that this method is to be used. A July memorandum to EPA regional administrators states that all I/M programs must "prohibit registration or provide some equally effective mechanism to prevent vehicles which do not comply with the applicable exhaust emission requirements from operating on the public roads."[1]

Although there are several procedures that the State can apply to tie enforcement to the registration process, one appears to be the most practical. First, a requirement would be established for motorists to prove that they either have successfully passed the emissions test or have been granted a waiver prior to reregistering their vehicles. Proof could be in the form of a stamp or other official marker being affixed to the registration renewal form at the time the vehicle passes the test or the waiver is granted. This would eliminate the need for handling any additional forms or other pieces of paper and should be fairly efficient. A similar system is utilized in Massachusetts where certain types of insurance coverage is mandatory. Prior to renewing registrations, the insurance carrier stamps the registration form indicating that the individual has the required coverage. The registration personnel, then, merely check to see that the form is stamped.

For initial registrations a grace period between the initial registration date and when compliance is required will be necessary. Thus, for example, owners of vehicles with initial registrations may have 60 days within which to pass an emissions inspection.

With renewal, enforcement is automatic since it is impossible to register vehicles without the forms being stamped. For initial registrations, the State could, for instance, require inspection within a given time period, say 30 to 60 days after registration. Visible proof of inspection or waiver in the form of a windshield sticker would eliminate the need for cross-referencing new registrations and emission inspections if the program included statewide coverage. However, since only a few counties are affected, a more positive form of enforcement such as cross-referencing may be required.

SECTION 6

LEGISLATIVE CONSIDERATIONS

INTRODUCTION

The purpose of this section is to analyze the issues that must be addressed by Wisconsin in the legislation that establishes the inspection/maintenance program. The actual legislation developed is instrumental to the success of the program in that it establishes the basic program framework, defines basic rules and regulations and administrative duties, and designates authority to operate the program. As such, the legislation must be broad enough to encompass all the necessary program elements and responsibilities, and yet have sufficient flexibility as to allow for necessary changes in the program over time as required by changing economic, political or other conditions.

APPROACH AND METHODOLOGY

The basic approach used in analyzing the legislative issues and requirements was to review all pertinent literature and documentation, and to analyze legislation from several other states where I/M bills have been successfully drafted. In connection with the basic literature review, the most relevant information is contained in various guidance documents and policy statements issued by the U.S. Environmental Protection Agency. The intent here is to define various technical and administrative requirements related to I/M legislation that apply in a general sense to any state where I/M is required by virtue of the 1977 Amendments to the Clean Air Act. It is important to note, however, that a complete discussion of the legislative issues and requirements for the state would have to consider existing statutes and legal requirements for preparing legislation that are specific to Wisconsin. This level of analysis was not undertaken primarily because it would more appropriately be undertaken through a joint effort among various state agencies and members of the State Legislature and their staffs.

LEGISLATIVE ISSUES

A number of issues relevant to I/M legislation were identified during the literature review. The following paragraphs present a discussion of these issues both in general terms, and in connection with specific legislation written in other states. The issues discussed include:

1. Authority to Implement I/M
2. Definitions
3. Authority to Establish Emission Test Standards
4. Authority to Grant Waivers and Exemptions
5. Authority to Contract with Private Contractors
6. Authority to Oversee Private Contractor
7. Enforcement and Penalties
8. Conflict of Interest Prohibition
9. Designation of Lead Agency and Other Agency Responsibilities
10. Licensing of Inspectors
11. Program Coverage
12. Vehicle Coverage
13. Inspection Frequency
14. Retest Policy
15. Repair Cost Limits
16. Fleet Inspections
17. Tampering
18. Documentation of Repairs Performed
19. Fees
20. Program Commencement and Phase-in Dates
21. Funding
22. Length of Program
23. Data Collection and Studies
24. Mechanics Training
25. Public Information Program

Authority to Implement I/M and Statement of Purpose

The basic statutory authority to implement an I/M program is stated in one or several sections of the I/M enabling legislation. Often in the section designating the responsibilities of the lead agency and other cooperating agencies the basic authority to implement and conduct the program is stated. Also, the authority to conduct various elements or tasks of the program such as to establish emission test standards, grant waivers and exemptions, to contract and oversee contractor responsibilities, to conduct enforcement and apply sanctions or penalties are all stipulated under various specific sections of the legislation. These specific issues are discussed below.

The statement of the basic intent and purpose including legislative findings of the need for the I/M program may be included at the beginning of the

I/M legislation. The inclusion of this section, which may be called a preamble, may depend on whether or not the enabling legislation is the first statute to introduce an inspection program for automobiles. An example of a preamble taken from a U.S. EPA model I/M bill is provided below:

MODEL LEGISLATION FOR MOTOR VEHICLE POLLUTION CONTROL

"Purpose

Legislative Findings: For purposes of public health and safety, the _________ finds:

(1) That the emission of pollutants from motor vehicles is a significant cause of air pollution in many sections of the State of _________.

(2) That the control and elimination of such pollutants are of utmost importance for the protection and preservation of the public health, safety and well-being.

(3) That each state has a responsibility to establish procedures, regulations and other provisions which comply with any promulgated federal laws to control or eliminate such pollutants.

The state Environmental Agency and all other agencies, departments or divisions of said departments and agencies shall provide by rules and regulations standards, guidelines, for the inspection of all registered vehicles (with promulgated exceptions) in said state, for the purpose of controlling exhaust emissions of any air contaminants."

Definitions

Typically, a separate section of the I/M legislation is provided specifically to define important words, and phrases used in the text of the legislation. As is the case in any law, having clear, unambiguous meanings is essential in order to avoid legal problems, misinterpretation, or unnecessary conflicts among agencies, individual citizens, or private groups with interests in the program. Some I/M legislation defines the key terms in the body of the text but most begin the law with a definitions section to establish clarity at the outset. Following is the definitions section from the New Jersey State Department of Environmental Protection Air Pollution Control Code, Chapter 15, Control and Prohibition of Air Pollution from Light-Duty Gasoline-Fueled Motor Vehicles, January 6, 1972:

"Section 1 - Definitions

1.1 PERSON: Includes corporations, companies, associations, societies, firms, partnerships and joint stock companies as well as individuals, and shall also include all political subdivisions of this State or any agencies or instrumentalities thereof.

1.2 MOTOR VEHICLE: Includes all vehicles propelled otherwise than by muscular power, excepting such vehicles as run only upon rails or tracks.

1.3 LIGHT-DUTY: Light-duty shall mean any motor vehicle designed primarily for transportation of persons or property and registered at 6,000 pounds gross weight or less.

1.4 MODEL YEAR OF VEHICLE: The production period of new motor vehicles or new motor vehicle engines designated by the calendar year in which such period ends. If the manufacturer does not designate a production period, the model year with respect to such vehicles or engines shall mean the 12-month period beginning January of the year in which production begins.

1.5 EXHAUST EMISSIONS: Substances emitted into the atmosphere from any opening downstream from the exhaust ports of a motor vehicle engine.

1.6 CRANKCASE EMISSIONS: Substances emitted into the atmosphere from any portion of the engine crankcase ventilation or lubrication systems.

1.7 SMOKE: Small gasborne and airborne particles, exclusive of water vapor, arising from a process of combustion in sufficient number to be observable.

1.8 CARBON MONOXIDE: A nonirritating, colorless, odorless gas at standard conditions which has the molecular form of CO.

1.9 HYDROCARBONS: Compounds whose molecules consist of atoms of hydrogen and carbon only.

1.10 APPROVED EXHAUST GAS ANALYTICAL SYSTEM: A device for sensing the amount of air contaminants in the exhaust emissions of a motor vehicle. For purposes of this Chapter this shall mean analyzing devices of the nondispersive infrared type sensitized to measure carbon monoxide at the 4.74 micron band expressed as percent carbon monoxide in air and to measure hydrocarbons as hexane at the 3.41 micron band expressed as parts per million of hydrocarbons (Hexane) in air. The device shall be a design meeting "SPECIFICATIONS FOR EXHAUST GAS ANALYTICAL SYSTEM" on file with the State Commissioner of Environmental Protection and approved for use in accordance with the manufacturer's recommended procedures for calibration and maintenance.

1.11 NEW MOTOR VEHICLE: A newly manufactured motor vehicle registered in New Jersey, prior to delivery to the ultimate purchaser.

1.12 NEW MOTOR VEHICLE DEALER: A sales agency, his employees, and/or agents licensed pursuant to N.J.S.A. 39:10-19 to sell new motor vehicles.

1.13 ULTIMATE PURCHASER: Any person, other than a motor vehicle dealer purchasing in his capacity as a motor vehicle dealer, who in good faith purchases a motor vehicle for purposes other than for resale as a motor vehicle dealer.

1.14 PREDELIVERY CHECKLIST: A schedule of items and procedures which a new motor vehicle dealer is required or requested by a manufacturer to check or follow prior to delivery of a new motor vehicle to the ultimate purchaser."

Authority to Establish Emission Test Standards

The success of an I/M program rests largely on the manner in which the maximum allowable emissions levels for vehicles are set. To achieve maximum emission reduction benefits while minimizing consumer inconvenience, several states are using standards or cutpoints that are specific to the type and model year of the vehicle. While it does increase in the complexity of certain aspects of the test procedure, it also ensures that the program is equitable in the sense that older, less well-controlled vehicles would not be tested against the same standard that newer, better controlled vehicles would be.

A draft of sample I/M legislation prepared by the EPA in 1976 indicates the types of variations in standards as a function of vehicle model year that would be reasonable for both idle and loaded mode testing; standards for idle tests are presented in Table 15 below.

Table 15. SAMPLE CUTPOINTS DEFINED AS A FUNCTION OF MODEL YEAR FOR THE IDLE MODE TEST

Model year	Maximum allowable	
	HC (ppm)	CO (%)
Pre-1968	1000	6.0
1968-69	600	5.0
1970-74	500	4.0
Post-1974	150	1.5

The EPA sample for loaded mode emission level standards is presented in a similar, but more detailed table (not included here).

The actual authority to establish cutpoints should rest with the agency administering the I/M program. The following quote from chapter 1154, Section 2, 39118 of the California Health and Safety Code illustrates this.

> "39118. With respect to the program designed and adopted by the Department of Consumer Affairs pursuant to Chapter 20.4 (commencing with Section 91889.50) of Division 3 of the Business and Professions Code, the board shall, in time for the Department of Consumer Affairs to comply with the schedule specified in subdivisions (a) and (b) of Section 9889.55, after public hearings, prescribe maximum air pollution emission standards to be applied in inspecting motor vehicles. In prescribing such standards, the board shall undertake such studies and experiments as are necessary and feasible, evaluate available data, and confer with automotive engineers. The standards shall be set at a level reasonably achievable for each

> class and model of motor vehicle when operating in a reasonably sound mechanical condition, allowing for the effects of installed emission control equipment and devices, and the motor vehicle's age and total mileage. The standards shall be designed to secure the operation of all such motor vehicles, as soon as possible, with a substantial reduction in air pollution emissions, and shall be revised from time-to-time, as experience justifies."

Section 36-1772, Part E of the Arizona Revised Statutes (ARS), Section R9-3-10063 states:

> "The director (of the Department of Health Services) shall adopt minimum emissions standards pursuant to Section 36-1717 with which the various classes of vehicles shall be required to comply after January 1, 1977. R9-3-1006 of ARS titled "The Mandatory Vehicular Emissions Inspection" states in Subsection E that "All tested vehicles must meet exhaust emissions standards as established in this subsection when their exhaust emissions are inspected under the conditions as prescribed in Subsection B of this section. Any vehicles that do not meet their prescribed standard shall fail their exhaust emission inspection." Subsection I then establishes emission standards based on a variety of factors.

It is important to empower the program administrator with the authority to set and revise the emission standards. There is an important balance between the emission standard and resulting failure level. As standards become more stringent, the failure levels increase. Because over a certain failure level there is only a marginal reduction in emission it is important to have the flexibility in setting the standards so as to maximize emission reductions and minimize overly high failure levels. A very high failure level could create a significant political backlash and jeopardize the program.

Power to Grant Exemptions/Waivers

The agency administering the I/M program should be empowered to establish exemptions for certain vehicle classes and grant waivers to specific vehicles under certain circumstances. Exemptions should be established based on equity considerations (vehicle age, repair cost, etc.), and practicality (i.e., vehicles that present difficulties in performing emissions inspections). The following list is representative, but not all inclusive, of exemption categories established by programs currently in force:

- Vehicle age (Wisconsin has tentatively chosen to exempt vehicles over 15 years old).
- Vehicles temporarily or permanently out of use and on private property.
- Failed vehicles that have undergone required repairs but are still out of compliance.

- Permanent four wheel drive vehicles (these vehicles cannot be tested with a loaded mode system).
- Vehicles with engine displacements less than a specified minimum.
- Special purpose vehicles such as prototypes, experimental models, etc.
- Motorcycles.

The power to grant waivers is important also. If one make of a certain model year cannot meet the emission levels established for that model year, it may prove more advantageous from the point of emission reductions to allow that make/model year vehicle to remain out of compliance rather than, for instance, lowering the standards to accommodate that vehicle.

Minnesota, for example, has stipulated that after consultation with the Commissioner of Public Safety the pollution control agency "shall exempt by rule, from all or any part of the mandatory periodic inspection," (a) motor vehicles registered as classic, pioneer, or collector, pursuant to Minnesota Statutes, Section 168.10; (b) motor vehicles used for racing or other exhibition purposes at places other than on public highways of the State and not generally operated under their own power upon any public highways; and (c) any class of motor vehicle which presents prohibitive inspection problems."

Arizona provides for "H.2. The exemption from inspection of (a) vehicles which are temporarily or permanently immobilized and placed on privately-owned lands; (b) a motor vehicle over 15 years old; (c) new vehicles originally registered at time of initial retail sale and titling in this state pursuant to Section 28-302."

Power to Contract With Private Firms

The agency designated to administer an I/M program must be empowered to enter into a contractual agreement with an independent firm that will conduct the actual inspections. The wording of this phrase can be straightforward. A few examples follow:

Minnesota:

"Sec. 4. (Inspection Stations) Subdivision 1. (Establishment of Inspection Stations, Contractor.) The agency, after consultation with the Commissioner, shall determine the appropriate number and geographic distribution of inspection facilities required to implement the motor vehicle inspection program and shall contract with a public or private entity to design, implement, construct, and operate the inspection program established by this act."

Arizona: (Chapter 158, House Bill 2319

"36-1775. Agreement with independent contractor; qualifications of contractor; agreement provisions.

A. The Director is authorized to enter into an emissions inspection agreement with one or more independent contractors subject to public bidding, to provide for the construction, equipment, establishment, maintenance and operation of an official emissions inspection stations in such numbers and locations as may be required to provide vehicle owners reasonably convenient access to inspection facilities for the purpose of obtaining compliance with this article and the rules and regulations adopted pursuant hereto."

Authority to Oversee Contractor

It is important that the State maintain authority to oversee the activities of the contractor charged with operating the I/M inspection facility network. The state should retain the authority to determine what data the contractor must collect and maintain and in what format it should be reported to the state (see 'Data Collection,' below).

Title 36, Chapter 14, Arizona Revised Statutes (ARS) Article 3, part 5-1775 deals with provisions in the agreement that the state may enter into or with a private contractor. Part D, sections 3 through 6 assure that the State will have sufficient authority to knowledgably oversee the contractor's operations. It states that, among other provisions, the agreement shall deal with, "3. The minimum requirements for adequate staff, equipment, management and hours and place of operation of official emissions inspection stations. 4. The submission of such reports and documentation concerning the operation of official emissions inspection stations as the director may require. 5. Surveillance by the Department of Health Services to ensure compliance with vehicular emissions standards, procedures, rules, regulations and laws. 6. Any other provision deemed necessary by the Director for the administration or enforcement of the emissions inspection agreement."

Enforcement and Penalties

The legislation must include mechanisms to ensure that the motor vehicles covered by the I/M program comply with the regulations. EPA policy states that all I/M programs must "prohibit registration or provide some equally effective mechanism to prevent vehicles which do not comply with the applicable exhaust emission requirements from operating on the public roads." Nearly all the states that are currently operating I/M programs utilize the registration procedure as the primary enforcement mechanism although other enforcement methods, such as the use of inspection stickers, are considered to be applicable.

Arizona utilizes an enforcement procedure that requires a vehicle owner to obtain evidence of I/M compliance and present it when he applies for a renewal or new vehicle registration. R9-3-1007 of the Arizona Department of Health Services (DHS) rules and regulations states: "Evidence of meeting state inspection requirements.

The evidence that a vehicle has met the State's inspection requirements shall be attested at the county assessor's office in one of the following manners:

A. Persons applying for renewal of registration shall provide either of the following documents:

1. An Arizona card for the vehicle with all its carbon copies attached and with a pass mark (for the emissions level test) affixed as specified in Section R9-3-1010 or,

2. A completed certificate of inspection for a vehicle that is part of a fleet qualifying under Sections R9-3-1019 and R9-3-1020.

B. Applicable vehicles sold by a holder of a fleet station permit and applying for transfer of title and registration shall provide any of the two following documents:

1. An Arizona certificate of title accompanied by a completed certificate of inspection.

2. A certificate of waiver.

C. Applicable vehicles with previous registrations that are being registered in Arizona for the first time and are being registered in Maricopa or Pima County by a person other than a holder of a fleet station permit shall provide a certificate of admittance with a pass mark affixed.

D. Applicable vehicles with previous registrations that are being registered in Arizona for the first time and are being registered in Maricopa or Pima County for a holder fleet station permit shall provide a completed certificate of inspection.

E. Vehicles that are receiving registration or title changes under any other circumstances other than described in this article shall not be required to show evidence of meeting the state's inspection requirements.

F. The county assessor shall ensure that each certificate of inspection accepted as evidence of meeting the inspection requirements of this article properly indicates whether the inspection was for the purpose of acquiring a new title or renewing registration."

In addition to the denial of registration for vehicles not in compliance with the basic requirement of having passed the emission test, there may be penalties or other sanctions for falsification of compliance forms, stickers, waiver forms, or other acts, the intent of which is to avoid compliance. The Colorado law, Section 42-4-315 states: "Penalties for false certificate and no certificate (of compliance). (1) No person shall make, issue, or knowingly use any imitation or deceptively similar or counterfeit certificate of emissions inspection."

In the Minnesota legislation the following penalties are stipulated:

"Section 9. (PENALTIES.) Subdivision 1. (a) Any employee of an official inspection station or of a fleet inspection station who certifies a motor vehicle as in compliance without having inspected its equipment and mechanisms, or who wilfully certifies a motor vehicle which has equipment and mechanism which do not meet or exceed the criteria and standards therefore, shall be guilty of a misdemeanor.

"(b) Any employee of an official inspection station who undertakes to furnish information to, recommend, suggest, or designate to a motor vehicle owner or operator, or any other person connected therewith, the name or any other description of a parts or repair facility or any other place where parts, repairs, or adjustments may be obtained to bring a motor vehicle into conformance with inspection requirements, shall be guilty of a misdemeanor.

"(c) Any person who materially alters or changes any equipment or mechanisms of a motor vehicle that has been certified to comply with standards promulgated under this act, which causes the motor vehicle to be in noncompliance with the standards and criteria, shall be guilty of a misdemeanor.

"(d) Any person who provides information to an inspection station on the extent or cost of repairs done to bring a motor vehicle into compliance with the standards promulgated under this act, when such repairs were not undertaken or when the cost was not as represented, shall be guilty of a misdemeanor."

Conflict of Interest Prohibition

It is essential for consumer protection purposes that the state be prohibited from entering into a contract with an entity that stands to profit from the outcome of emissions inspections tests. Businesses that buy, sell, maintain, or repair vehicles, or that sell repair parts are particularly prohibited in most legislation.

In Section 4 again, Minnesota admonishes, "The agency shall not contract with any person who is engaged in the business of selling, maintaining, or repairing motor vehicles or selling motor vehicle replacement or repair parts at retail in this State, except that the contractor may repair any motor vehicle owned or operated by the contractor." Subdivision 2 (repairs) states, "The word 'inspection' as used in this section shall not include repairs and adjustments. Repairs or adjustments necessary to bring a motor vehicle into conformance with the criteria and standards under this act shall be the responsibility of the motor vehicle owner and may be made by the owner or any repair facility of his choosing."

A potential enabling act in Connecticut states in Section 4(b) that, "the Commissioner of Motor Vehicles and the Commissioner of Environmental Protection are prohibited from entering into an inspection agreement with any independent contractor who: (i) is engaged in the business of maintaining or repairing vehicles in this state, except that the independent contractor shall not be precluded from maintaining or repairing any vehicle owned or operated by the independent contractor. (ii) Does not have capability, resources or technical and management skill to adequately conduct, equip, operate and maintain a sufficient number of official inspection stations to meet the demand for inspection of every vehicle which is required to be submitted for inspection pursuant to this act."

Designation of Lead Agency

The lead agency should be designated in the program's enabling legislation. In addition to establishing the lead agency several states (California, Colorado, Nevada, New Jersey) have named the Department of Motor Vehicles (DMV) as a cooperative agency to assist in program operation. In Wisconsin, it is likely that the Department of Transportation will assume the lead role with direct support being provided by the Departments of Natural Resources and Agriculture.

In California Senate Bill No. 479, Chapter 1154 states: "...requires the Department of Consumer Affairs, with the cooperation of the Department of the California Highway Patrol and the (Air Resources) Board, to design and adopt a program for the mandatory periodic exhaust emission inspection of all motor vehicles registered in such counties, and prescribes specified duties in connection therewith." In August 1976 Assembly Bill No. 4161 transfered administrative control from the Department of Consumer Affairs to the State Air Resources Board.

In several statutes the lead agency is presented in the "definitions" section. The original bill that created mandatory I/M in Arizona (House Bill 2319, Chapter 158) defines "department" as the Department of Health Services (DHS) and "director" as the director of the DHS. The bill then defines duties that the director must assume; "The director shall administer a comprehensive annual emissions inspection program which shall require the inspection of vehicles in this state in accordance with the provisions of law or administrative regulations pursuant to this article."

A proposed act in Connecticut in 1976 designed to establish an I/M program states, "the Commissioner of Motor Vehicles may adopt regulations for the construction, equipping, maintenance, and operation of official inspection stations and for the enforcement of the provisions of this act. Such regulations shall provide for the efficient conduct of inspections for emissions and the presence of air pollution control devices and may include tests to determine whether the vehicle is in safe operating condition."

Licensing of Inspectors

Some state's I/M legislation may specify the requirements for licensing and/or training of the official motor vehicle emission inspectors. Other state's legislation does not include this level of detail and such specifications are then made as rules by the lead agency. The same requirements for becoming an emission inspector may be used by the state regardless of whether the state selects a contractor or state-run approval. An example of legislation concerning the licensing of inspectors is contained in the Arizona legislation which follows:

"R9-3-1016 Licensing of Inspectors:

"A. No person will be licensed as a vehicular emissions inspector unless he has demonstrated his competence to the department by such examination, training, or other standards as the director may approve.

B. Applications will be obtained from, and approved by, the department.

C. All completed applications will be returned to the department.

D. Any vehicular emissions inspector inspecting a diesel-powered vehicle as prescribed herein must have successfully completed an approved training course for visually reading opacity with the unaided eye within the last six months or must use an opacity meter that is a full-flow, direct reading, continuous reading light extinction type using a collimated light source and photoelectric cell, and is accurate within plus-or-minus 5%.

E. Licenses issued to vehicular emissions inspectors shall be renewed annually on or before December 31, except that no license shall be renewed twice in any calendar year.

F. Applications for renewal of vehicular emissions fleet inspector's licenses shall be submitted thirty days prior to the current license expiration date.

G. The department may suspend, revoke, or refuse to renew the license if an applicant has violated any applicable rule or regulation issued by the department.

H. The department may suspend, revoke, or refuse to renew the license issued to an inspector when he has intentionally failed to properly inspect a vehicle in compliance with regulations adopted by the director.

I. A vehicular emissions inspector shall inform the department of any change in his employment status within seven days of such change.

J. Each vehicular emissions inspector shall be assigned a single, unique, nontransferable inspector's number. No vehicular emissions inspector shall be assigned more than one inspector's number during his lifetime."

Program Coverage

The geographical area the program will cover should be defined specifically in the legislation. In Wisconsin the geographical area will include nine counties. According to U.S. EPA "I/M should focus on the metropolitan areas and should include the entire urbanized area and adjacent fringe areas of development. Boundaries of the area affected may be adjusted if an equivalent emission reduction is achieved. For urbanized areas of 200,000 population or greater which need I/M to obtain an extension of the 1982 attainment date, full mandatory I/M must be implemented by the deadlines..."

Arizona House Bill 2319, Chapter 158, quoted above, continues, "such inspection shall commence in counties with a population in excess of three hundred fifty thousand by January 1, 1976. Inspection in other counties of the state will commence when required by the director to meet air pollution control standards or upon application by a county board of supervisors for participation in such inspection program, subject to approval by the director."

Vehicle Coverage

In addition to defining the geographical coverage of the I/M program, the enabling legislation should specify the types of vehicles to be included in the program. U.S. EPA guidelines stipulate that all I/M programs must "provide for regular periodic inspections of all vehicles for which emission reductions are claimed." The emission reduction benefits are calculated, according to specific certain emission reduction credits defined by EPA. Credits are defined for light-duty vehicles (LDV's) and two categories of light-duty trucks. Light-duty trucks are defined as a vehicle category consisting of trucks used chiefly for personal transportation that are (generally) powered by gasoline-fueled, spark-ignited internal combustion engines. Two subcategories of light-duty trucks are used: trucks having a gross vehicle weight (GVW) in the range of 0 to 6000 pounds (LDT1), and trucks with GVW in the range of 6001 to 8500 pounds (LDT2). Trucks in these two categories are essentially all two-axle, four tire trucks. Light-duty vehicles (LDV) are primarily vehicles used for personal transportation with a GVW of up to 8500 pounds. Emission credits have not been defined for light-duty diesel trucks and heavy-duty trucks (gasoline and diesel).

Different states have defined the relevant vehicle population differently. Minnesota states that procedures shall be established "for the annual inspection of all motor vehicles registered by residents of the metropolitan area for air pollution emissions,..." "Motor vehicle means any self-propelled motor vehicle weighing less than 8500 pounds and licensed for use upon the public highways of the state for transportation of persons or property." The Minnesota statute also provides for inspection prior to initial registration for new motor vehicle sales and for inspection of vehicles owned by new residents within the area of program coverage. Regarding the latter issue, the statute states "In addition to annual inspection, a motor vehicle when first registered to a resident of the metropolitan area following a move by that person from out of the state shall be inspected for compliance with the inspection standards under this act prior to the initial registration in Minnesota."

Arizona's House bill 2319, Chapter 158 states, "Vehicles required to be inspected and registered in this State except those provided for in Section 36-1776 (a list of exemptions), shall be inspected in accordance with the provisions of this Article..." "Vehicle" means any automobile, truck, truck tractor, motor bus or any self-propelled or motor-driven vehicle registered or to be registered in this State and used upon the public highways of this State for the purpose of transporting persons or property, except implements of husbandry, road rollers or road machines temporarily operated upon the highway."

In addition to enumerating the vehicle types affected by an I/M program, vehicles that change hands must be considered. These vehicles may be new cars that are sold for the first time, used vehicles sold by dealers within the area of program coverage, used vehicles sold by dealers outside the area of program coverage, vehicles sold by one individual to another and vehicles owned by people who move their residence from outside the program's geographic coverage into it.

Existing programs treat these vehicles in fairly consistent ways. When a vehicle changes hands between individuals some states require reinspection by the new owner if it has not been inspected within 60 days prior to the sale date. Elsewhere, no specific requirement is made, that is, the vehicle must be inspected again within 30 days prior to reregistration by the new owner.

Vehicles owned by individuals moving into Wisconsin may be treated in one of several ways. Inspection can be required upon registration within the state for all such vehicles. Alternately, all such vehicles can enter the state without being inspected, falling under the inspection requirement prior to reregistration in the usual manner. It may be feasible to follow this policy for vehicles previously registered in an area with emissions inspection while requiring vehicles entering from jurisdictions without I/M to undergo a test and meet emission level standards within a certain time after entering Wisconsin.

The type of policy established regarding vehicles changing hands and entering the relevant vehicle population will be dictated largely by the practical problems of establishing viable enforcement measures for the policy chosen. The most practical form of enforcement is to tie I/M requirements to vehicle registration requirements (see the discussion on Enforcement).

Inspection Frequency

Generally, the more frequently a motor vehicle is inspected, the more likely it is that its emissions will approach the minimum level. Although the emission deterioration characteristics of motor vehicles vary from vehicle to vehicle and as a function of many other external factors, it has generally been found that carbon monoxide emissions tend to deteriorate back to pre-inspection levels over a period of about a year, while hydrocarbon emission rates deteriorate somewhat more quickly. EPA policy states that I/M programs must require inspections to be performed on a regular, periodic basis but does not stipulate the exact interval. From a practical standpoint a program whereby inspections are performed more frequently than annually is not desirable. Nearly all states have chosen an annual inspection cycle, which is generally integrated into the motor vehicle registration process for enforcement. Since registration in Wisconsin is on an annual basis, a 1-year inspection interval would be appropriate.

Most existing legislation defines the frequency of inspections in a straightforward manner. Minnesota established "procedures for the annual inspection of all motor vehicles..." Rhode Island states that "31-38-2c. Vehicles required to be inspected in this State shall be inspected at least once within each twelve (12) month period in accordance with rules and regulations established by the Registrar" (of Motor Vehicles). Other enabling legislation is worded similarly.

Retest Policy

There are a number of ways to deal with the issue of retesting vehicles that have failed to meet established emission standards. Having the failed vehicles return to the test facility within a specified time after failing is common to most programs currently in operation. Vehicles failing the inspection are generally required to have appropriate maintenance performed and then return to the inspection station for a retest. The time limit between the initial inspection and retest ranges from 15 to 30 days depending on the state.

Another important issue is whether or not retests will be paid or free to the motorist. To insure consumer acceptance the typical approach is to provide retests within a specified time period at no additional charge. This creates an incentive to bring failed vehicles into compliance promptly, as well as reducing the economic impact of failing the test.

The regulations relating to the time period a failed vehicle is allowed before it must be retested need not be stated in the enabling legislation of an emissions inspection program. It may be appropriate to leave this matter to the discretion of the director of the agency charged with administering the program.

Arizona has included a phrase in House Bill 2313-F that deals with failed vehicles. It reads, "36-1773 D. Any person whose vehicle has been inspected at an official inspection station shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within thirty consecutive calendar days, but not thereafter, to return such vehicle for one reinspection without charge." Rhode Island legislation reads similarly; "Any person whose vehicle has been inspected at an official inspection station, shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within twenty (20) consecutive calendar days, but not thereafter, to return such vehicle for one (1) reinspection without charge."

Repair Cost Limits

Any program that requires individuals to make purchases must be both equitable and practical if it is to be successful. The mandatory repairs required by an I/M program to bring all vehicles within established guidelines for allowable emissions must have limits placed on the magnitude of the cost of required repairs. This ceiling will help prevent the program from becoming an excessive burden on the public. Also, for certain vehicles the cost of complying may be so great as to render their operation prohibitively expensive. To ameliorate these problems, repair cost ceilings are usually specified.

These limits may take either/or a combination of two forms. First, an absolute dollar limit on the expense of mandated repairs may be set. If a vehicle owner can show that repairs have been performed up to that limit, the vehicle registration is allowed, regardless of whether or not the vehicle emission level is within standards or not. A second type of limit is defined as a function of the value of the vehicle. Minnesota has adopted such a provision in subdivision 5 of its statute. "Maximum Repair Cost. 1(a) The maximum repair cost for meeting emission standards not covered by any warranty, shall be as follows: a motor vehicle having a value of $2,000 or less, $50, for each full $500 of vehicle value over $2,000, an additional $10. Motor vehicle values shall be determined as provided in Minnesota Statutes, Section 168.013." When absolute dollar limits are used, they are usually set at $50 or $75 with provisions to increase it over time.

Fleet Inspections

Several states have established procedures for certifying owners of fleets of vehicles to self-inspect their vehicles. Commonly included are private or government organizations (other than the Federal Government) that owns or operates a number of vehicles where it is deemed that self-inspection would be more cost effective than requiring that each vehicle travel to the state or contractor inspection stations. Most states have certified fleet inspection stations and have set the number of vehicles needed to qualify for being classified as a fleet at about 15 to 25 vehicles. Fleets include state, city or local government agency vehicles, taxi fleets, rental vehicles, etc.

The benefits of having certified fleet inspection stations include both cost savings to the fleet owners and a potential reduction in the number of centralized inspection stations.

It is important that the state establish adequate supervision and quality assurance controls on the fleet inspection stations. The enabling legislation must stipulate the requirements for certification for fleet stations, surveillance procedures, equipment calibration requirements, and procedures and reasons for revocation of permits.

Section 36-1776 of the Arizona Revised Statutes, entitled "Fleet emissions inspection stations; certificates of inspection; dealer's inventory, investigations; revocation of permit" deals with several issues relating to fleet inspections. It establishes that a registered owner or lessee of a fleet of at least 25 vehicles is eligible to apply to the Director of the Department of Health Services (the I/M program's adminstrative agency in Arizona) for a permit to establish a fleet emissions inpection station. There are several requirements that must be met before thedirector can issue a permit. They are:

> "that the applicant:
> 1. Maintains an established place of business for the repair and maintenance of applicant's fleet of vehicles.
> 2. Has obtained approved machinery,tools and equipment to adequately conduct the required emission inspections, except that notwithstanding any other provisionsof this article, or rules or regulations promulgated hereunder fleet emission inspection stations shall be permitted to inspet vehicles owned or leased by the fleet emission inspection staions, by using either an idle test condition or a loaded testcondition.

3. Employs properly trained and licensed personnel with which to perform the necessary labor.
4. Agrees to provide data as may be prescribed by the director."

The statute stipulates that only vehicles found to comply with applicable regulations, "that is meet tailpipe emission level standards," may have certificates of compliance issued to them. The fleet emissions inspection station permit holder is not allowed to inspect or certify any vehicle not owned or leased by the holder. An important phrase which establishes dealer inventory as part of a dealer's fleet, and hence eligible for fleet inspections by the dealer reads, "Vehicles owned by a licensed vehicle dealer and which are held for resale as a part of the dealer's business inventory shall be deemed a part of such dealer's vehicle fleet for purposes of this section."

Part F of Section 36-1776 provides the Director of the Department of Health Services with the authority to investigate fleet inspection stations to verify their compliance with these regulations.

"The director shall investigate the operation of each fleet emissions inspection station as the conditions and circumstances of such operation may indicate. He may require the holder of any fleet permit to submit such documentation required concerning the operation of such inspection station. The director may revoke and require the surrender and forfeiture of any fleet emissions inspection station permit and certificates of inspection of such permittee if he finds that such station is not operated in accordance with this article and the lawful rules and regulations adopted by the director or the holder of such permit has failed or refused to submit records or documentation required."

Minnesota has also addressed the issue of fleet inspection stations. Owners of fleets of 15 or more motor vehicles may apply for fleet inspection station licenses. The applicant must show that "he has facilities, equipment, and personnel to competently perform the inspection." Minnesota also treats motor vehicle inventories held by dealers as part of the dealer's fleet. "All motor vehicles held for resale shall be considered as 'owned' until such time as the motor vehicle is titled in a purchaser's name or otherwise disposed of." The legislation stipulates how many fleet vehicles the pollution control agency may inspect to verify the action taken by a fleet inspection station. "The agency may require owners of fleets of motor vehicles to submit motor vehicles designated by the agency numbering five percent or two motor vehicles, whichever is larger, to inspection annually at official inspection stations, to insure compliance with the provisions of this section."

Minnesota also spells out policy on hearings when a licensee has his license revoked or suspended and when an application for a license is refused. "The agency may revoke or suspend any fleet inspection station license upon a finding that any motor vehicle was wrongly certified as in compliance and may refuse, suspend, or revoke the license upon a finding the licensee does not have the equipment, facilities, or personnel to competently perform inspections as required by this act, or for other just cause. In the event of any refusal, suspension, or revocation of a fleet inspection station license, the licensee or applicant may request, within 30 days of the agency's action, pursuant to Minnesota Statutes, Chapter 15. If a hearing is requested no suspension or revocation shall be effective until after the decision based upon the hearing."

Tampering

Both the Wisconsin Departments of Transportation and Natural Resources have provisions to check whether or not vehicle emission control equipment has been tampered with. In addition to establishing these procedures, penalties have been defined for persons found guilty of tampering with (disconnecting) air pollution control devices and systems.

Removing or disconnecting any ". . . vehicle emission control devices originally installed by the manufacturer or comparable tested placement devices. . ." on any vehicle operated on Wisconsin highways is unlawful according to Subchapter IV, Exhaust and Fuel Systems, of the Department of Transportation, Standards for Motor Vehicle Equipment. Furthermore, MVD 5, Subchapter IX, Homemade or Reconstructed Motor Vehicles, states that it is unlawful for ". . . any vehicle. . .homemade or reconstructed using a 1968 model year engine or later. . ." to be operated on a highway if it does not have proper emission control devices."

The New Dealer's Unit of the DOT's Division of Enforcement has been empowered to enforce these provisions as prescribed in Section 110.075 (7) of the Wisconsin Statutes. In supervising all of the new and used motor vehicles sales operations in the State, the Unit may refuse or deny any dealers found in violation of the regulations the right to do business. The Wisconsin Department of Natural Resources may levy fines of from $10 to $5,000 upon persons violating Section 144.42 Motor Vehicle Pollution, Excerpts of Chapter 83, Laws of 1967. Authority provided through this regulation reads as follows:

> "(2) Except as permitted or authorized by law, no person shall fail to maintain in good working order or remove, dismantle or otherwise cause to be inoperative any equipment or feature constituting an operational element of the air pollution control system or mechanism of a motor vehicle and required by rules of the department to be maintained in or on the vehicle. Any such failure to maintain in good working order or removal, dismantling or causing of inoperability shall subject the owner or operator to suspension or cancellation of the registration for the vehicle. The vehicle shall not thereafter be eligible for registration until all parts and equipment constituting operational elements of the motor vehicle have been restored, replaced or repaired and are in good working order."

Documentation of Repairs Performed

It is of value to collect data on repairs required by an I/M program in order to evaluate its impact and assure that vehicles returning for reinspection have actually undergone the necessary repairs. If exemptions are granted to vehicles that fail reinspection after having repairs performed, it is essential that some form of documentation be prepared by those actually performing repairs. This type of data would also be necessary to provide the basis for evaluating the efficiency of individual repair shops in performing maintenance and thus would play an integral role in both consumer protection and quality control programs. Further, these data would be useful as input for an overall program evaluation effort, which should be undertaken periodically.

Fees

Enabling legislation generally sets a maximum fee that may be charged for performing a motor vehicle inspection. How many reinspections, if any, covered by the fee collected should also be stipulated? In the event that vehicles are required to undergo reinspections that are not included in the basic fee, the ceiling costs performing the additional inspections should be stated, also.

Minnesota deals with this issue in the following manner: "[Fee for Inspection.] (a) An inspection fee of not to exceed $10 shall be paid at the official inspection station at the time any motor vehicle is inspected. The inspection fee shall entitle the owner of the motor vehicle to one initial inspection and, if necessary, one full or partial reinspection, at the official inspection station. If two or more reinspections are required, an additional fee of not more than $7.50 per full or partial reinspection shall be set by the agency and charged in the same manner at the time of reinspection. The fee shall cover the contract cost of the inspection and the administration costs of the agency and department under this act. The fee for motor vehicles inspected in a fleet inspection station shall be set by the agency to equal the costs of agency and department fleet license and program administration only. The inspection fee shall also apply to vehicles exempt from license fees pursuant to Minnesota Statutes, Section 68.012."

The last two sentences are particularly important. The first insures that the I/M program will be self-supporting. The fee charged per inspection must be set high enough to cover costs that are incurred in performing the inspection. This is a desirable feature and appears in virtually all I/M enabling legislation.

The last sentence allows a fee to be charged for all vehicles exempt from license fees. These vehicles are usually owned by units of government that are "higher up" than the governmental unit levying the fee. In this case, it is concerned with federally owned vehicles.

Legislation for other programs cover similar issues, but may be worded differently. Arizona, for example, specifies that fees will be collected along with each vehicle's annual registration charge. This approach provides a positive method of collecting fees that is low in cost. Section 36-1773 of the Arizona Revised Statutes reads as follows:

> "Emission inspection fees; composition and disposition
> A. The director shall fix, regulate and alter in accordance with this section, the fees, not to exceed five dollars per inspection, required to be paid for the inspection of every vehicle inspected pursuant to this article.
> B. The director shall fix the fees, not to exceed five dollars per inspection. Such fees shall be originally fixed and thereafter adjusted by the director to reflect the contractual charge payable to any independent contractor as well as increase or decrease in costs to the state of providing and administering emissions inspection services.
> C. The fees charged for official emissions inspection shall be uniform as applied to each class of vehicle which shall be defined by the director. Except for fees collected by the director pursuant to Section 36-1776, the inspection fee shall be collected with the registration fee by the county assessor at the time and place of motor vehicle registration pursuant to title 28, chapter 3, section 1, and:
> 1. The assessor of each county is constituted an agent of the department of transportation for the collection of the emissions inspection fee.
> 2. All monies received from inspection fees by the county assessor shall be immediately transferred by the collecting officer to the state treasurer and by him to the emissions inspection fund.
> D. Any person whose vehicle has been inspected at an official emissions inspection station shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within thirty consecutive calendar days but not thereafter to return such vehicle for one reinspection without charge."

Section 9889.61, Part B of Chapter 1154 of the California Vehicle Code states, "The department shall charge a fee for the inspection of motor vehicles conducted pursuant to Section 9889.55. The revenues from such fees shall be sufficient to provide the State funds to match any federal grants awarded in response to application under subdivision (a), and to reimburse the Motor Vehicle Account in the Transportation Tax Fund for all appropriations made for the design, adoption, implementation, and operation of the inspection program established by this chapter."

Chapter 38 of the general laws of Rhode Island, entitled "Inspection of Motor Vehicles" deals with fees in the following way:

> "31-38.3 Inspection fees; composition and disposition.
> a. The registrar (of Motor Vehicles) shall fix, regulate and alter in accordance with this section, the fees required to be paid for the inspection of every vehicle inspected pursuant to this chapter. Such fees shall be originally fixed and thereafter adjusted by the registrar to reflect the contractual charge payable to any independent contractor as well as any

increase or decrease in the costs to the state of providing and administering inspection services.

b. The fees charged for official inspection shall be uniform throughout the State and shall be collected at the point of inspection.

c. Any person whose vehicle has been inspected at an official inspection station, shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within twenty (20) consecutive calendar days, but not thereafter, to return such vehicle for one (1) reinspection without charge."

Program Commencement and Phase-in Dates

The I/M program commencement date must be stated in the enabling legislation. Several states have implemented programs in phases, often beginning with mandatory inspection but voluntary maintenance. The mandatory maintenance usually begins after 1 year. This approach has been very beneficial since it gives the public time to become acquainted with the basic I/M concepts. Also, it has other important benefits such as allowing time for the repair industry to gain the necessary training and experience in emission related repairs.

Arizona's I/M program began with a 1-year voluntary maintenance period. The sections of Arizona regulations dealing with this issue are R9-3-1004 Parts A and B and they read as follows: "A. Pursuant to ARS §36-1772, all vehicles required by this article to be subjected to the mandatory vehicular emissions inspection shall be required to be inspected, but, from 12:01 a.m. on January 1, 1976 to 12:01 a.m. on January 1, 1977, shall not be required to pass inspection. B. All vehicles required by this article to be subjected to the mandatory vehicular emissions inspection shall be required to pass the inspections subsequent to 12:01 a.m. on January 1, 1977." Section 36-1772 of the Arizona Revised Statutes is referred to by this passage. Section 36-1772 establishes I/M in Arizona. Regarding program commencement it states in Part A of this section that "such inspection shall commence in counties with a population in excess of three hundred fifty thousand by January 1, 1976."

Thus, it is appropriate to establish the date on which an I/M program is initiated in the enabling legislation and determine how to phase it in, should a gradual implementation approach be chosen, via adoption of rules and regulations by the director of the program's administering agency.

Funding

Many states' enabling legislation establish the funding mechanism required for the program. Often this section is included with the fee section, although it may be separate. The funds section first establishes the fund, defines the revenue sources for it, establishes authorized expenditures from it, defines exemptions, and may establish any investment policies. The major revenue sources for the inspection fund generally would be general state appropriations, grants (especially Federal grants), fees from the inspections, and bonds if established for the program. The Arizona legislation established an inspection fund in House Bill 2319 which reads as follows:

> "36-1774. Emissions inspection fund, composition; authorized expenditures; exemptions; investment
>
> A. There is established an emissions inspection fund which shall consist of:
>
> 1. Money appropriated thereto by the legislature.
> 2. All money remitted by owners of vehicles which is collected for emissions inspection.
> 3. All money collected by the Director for the issuance of inspection certificates to owners of fleet emissions inspection stations.
> 4. Money received from private grants or donations when so designated by the grantor or donor.
> 5. Money received from the United States by grant or otherwise to assist the State in any emissions inspection program.
>
> B. The Director of Administration shall approve properly certified claims submitted by the Department of Administration for enforcement of the provisions of this article. When such claims for reimbursement are approved by the Director and transmitted to the State Treasurer, he shall transfer the amounts claimed to the Director of the Department of Health Services.
>
> C. No monies in the emissions inspection fund shall revert to the general fund or the Department of Health Services and such monies shall be exempt from the provision of Section 35-190, relating to lapsing of appropriations until January 1, 1981.
>
> Providing and administering emissions inspection services.
>
> C. The fees charged for official emissions inspection shall be uniform as applied to each class of vehicle which shall be defined by the Director. Except for fees collected by the Director pursuant to Section 36-1776, the inspection fee shall be collected with the registration fee by the County Assessor at the time and place of motor vehicle registration pursuant to Title 28, Chapter 3, Article 1 and:
>
> 1. The Assessor of each county is constituted an agent of the Department of Transportation for the collection of the emissions inspection fee.
> 2. All monies received from inspection fees by the County Assessor shall be immediately transferred by the collecting officer to the Director of the Department of Transportation and by him to the emissions inspection fund.
>
> D. Any person whose vehicle has been inspected at an official emissions inspection station shall, if such vehicle was not found to comply with the minimum standards, have his vehicle repaired and have the right within thirty consecutive calendar days but not thereafter to return such vehicle for one reinspection without charge.
>
> E. The Director shall fix an emissions inspection fee before inspection certificates may be issued to the owner of any fleet emissions inspection station. Such fee shall be uniform for each inspection certificate issued and shall be based upon the Director's

estimated costs to the State of administering and enforcing the provisions of this article as they apply to fleet emissions inspection stations and the vehicles inspected therein. The Director shall promptly transmit all such monies collected by him pursuant to this article to the State Treasurer who shall deposit them in the emissions inspection fund."

Based on other states' programs, an optimum contract period appears to be 5 years. Longer periods bring with them uncertainties about costs and political factors. In addition, it would be important that the state be able to terminate the contract as appropriate at the end of the 5 years (or sooner if need be) with the option of taking over the program, renegotiating with the same operator or contracting with another operator. Contracts of less than 5 years would be financially unattractive to potential contractors unless the initial investments and startup costs were shared between the contractor and the State, or similar arrangements made that would absolve the contractor from making very high initial investments.

Arizona established a 5-year contract in House Bill 2319, Section 36-1775, Part D 1: "A contract term or duration of five years with equitable compensation to the contractor if the provisions of this article are repealed."

Minnesota established a 5-year minimum contract length: "Sec. 4 .... Any contract authorized by this section shall contain, in addition to other provisions, a contract duration for actual operation of the inspection stations of a minimum of five years, and provision for equitable compensation to the contractor, if the provisions of this act are repealed prior to the expiration of the contract term."

Length of Program - Termination or Extension of Contract

The overall duration of an I/M program itself does not have to be specified in the enabling legislation. However, in a contractor approach, the exact time that the contract runs as well as contract termination procedures and provisions are often included. A closely related issue is the fee paid to the contractor. To keep the fee constant over the contract period, the effect of inflation must be taken into account. Correcting for inflation, the fee paid will be in excess of a contractor's costs at the start of a program and below the contractor's costs at the end. The contract duration should reflect the time period use to calculate the constant fee. This prevents contractors from making excess profits now, and assures that the contractor will still be performing inspections when costs exceed fees later on.

Data Collection and Studies

Whether Wisconsin selects a contractor or state-run I/M system, it will be necessary to establish in the enabling legislation the authority (requirements, actually) to collect data and conduct studies of individual inspection station performance, repair costs, and overall program effectiveness. Generally in a contractor system, the contractor collects the data, which is subsequently analyzed by the appropriate state agency; alternatively, in a state-run system, the state would collect and analyze the data and its effectiveness.

In either approach, the director of the administrative agency is empowered by the enabling legislation to collect and maintain data files.

California has stipulated in Section 8, Section 9889.58 of the Business and Professions Code that information maintained in the records of all facilities performing inspections shall include all of the following:

> "(a) the number of maintenance and repair operations performed on motor vehicles which failed to pass an inspection conducted by the department pursuant to the provisions of this chapter.
> (b) the correlation between maintenance and repairs recommended by the department pursuant to subdivision (b) of Section 9889.51 and maintenance and repairs performed.
> (c) the percentage of maintained and repaired vehicles which passed reinspection.
> (d) the charges assessed for such maintenance and repairs.
> (e) any other information deemed essential by the department."

When an RFP (Request for Proposal) is promulgated and rules and regulations are established, a more complete and refined list of data requirements should be set forth. It should include, but not be limited to, the following:

- vehicle identification number
- test results
- vehicle age
- repairs needed for failed vehicles
- cost of repairs performed on failed vehicles (labor/parts)
- analyzer calibration records (frequency, accuracy, etc.)
- vehicle license number
- owner's name
- number of cylinders*
- vehicle weight class*
- air injection code*

An important element of data collection relates to the need for studies of program effectiveness and periodic revision of certain program elements. Such studies would be particularly important during the early planning stages and, if a contractor were selected towards the end of the contract period.

The Minnesota statute makes the following provisions for data collection and studies:

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*to allow for make/model specific cut-points

> "Subd. 2. (STUDIES, DATA COLLECTIONS, ANNUAL REPORT.)
> The commissioner and the agency shall collect data and undertake studies as are necessary to evaluate the cost, effectiveness, and benefits of the motor vehicle inspection program. The director, the commissioner, the commissioner of transportation and the director of the energy agency or their designees, shall jointly constitute an advisory committee to consider among other issues related to motor vehicle inspection the following:
> (a) the cost, effectiveness, and benefits of the inspection program;
> (b) whether vehicles weighing over 8,500 pounds should be included in the inspection program;
> (c) whether mandatory inspection of motor vehicles should be extended to other areas of the state;
> (d) the desirability of certification, licensing, or bonding of repair facilities for the protection of the public; and
> (e) the desirability of allowing official inspection facility personnel to make minor adjustments with the consent of the motor vehicle owner.
> The director of the agency, or his designee, shall be the chairman of the committee. The director and the committee shall seek information from the general public, consumer groups, environmental groups, and the repair and parts industry regarding these matters, and may establish an advisory committee on motor vehicle inspection if it deems advisable. The agency shall report on these matters and the general operation of the motor vehicle inspection program to the legislature on or before January 1, 1982 and each four years thereafter."

Mechanic Training

Some states specifically have provisions in the I/M enabling legislation that mechanic training courses be conducted. Generally, the important aspects of this section are to establish the requirement for such training and define which agency is to be responsible for setting up and administering the program. It is also possible that the designated agency would hire a contractor solely for the purposes of designing and operating a mechanic training program. In the Minnesota legislation the following wording is used:

> "Sec. 8....(b) The agency, in cooperation with the commissioner, shall provide information on motor vehicle repairs and conduct vehicle repair seminars and training programs for the public and repair industry."

Public Information Program

Some mention of the type of public information program and the approximate scope it should encompass should be made. Enabling legislation should specify who is empowered to establish this effort. The methods of information promulgation (mass media, direct mailings, etc.) may be specified. Alternately, it may be sufficient to state that each motor vehicle owner affected by an

I/M program should be made aware of certain aspects of the program; i.e., program goals, program requirements, location and hours of inspection facilities, etc. If Wisconsin establishes a contractor-run network with computer capabilities, it can require that the contractor provide consumer protection information along with a fail report to all owners of vehicles that do not meet standards. This information may include, but not necessarily be limited to, a list of probable conditions that are causing the vehicle to be out of compliance and a list of recommended repair centers.

It is important to specify when the public information effort will commence and the level of effort over time. The actual dissemination of information should begin sometime prior to the program's starting date. Usually this occurs between 6 months and 1 year prior to the first inspection.

The actual wording of the section of the enabling legislation dealing with this issue will depend on how the phasein sequence is handled.

Minnesota dealt with this matter in the following manner:

> "Sec. 8. (Public Information, Training.)
> (a) The agency, in cooperation with the commissioner, and in conjunction with the official inspection station contractor, shall design, prepare, and implement a public education and information program for the motor vehicle inspection program, including, but not limited to, materials for distribution, presentations, mass media releases, and other appropriate public educational items. The public education program shall commence a minimum of six months before mandatory motor vehicle inspection is required.
> (b) The agency, in cooperation with the commissioner, shall provide information on motor vehicle repairs and conduct vehicle repair seminars and training programs for the public and repair industry."

SECTION 7

COST ANALYSIS

METHODOLOGY

The technique used in developing the cost analysis presented in this Section was to focus on specific cost categories, enabling very straightforward comparisons between a network of state owned and operated, centralized facilities and an identical network of private contractor owned and operated centralized facilities. Table 16 provides a detailed outline of specific cost categories, and elements thereof, that were used in the cost analysis.

All costs specified in this section , except where otherwise indicated, are reported in constant 1978 dollars (i.e., inflation is assumed to be nonexistent). Methodologies used in developing costs for the specific elements outlined in Table 16 are discussed below.

Initial Capital Costs

These costs reflect the initial expenditures required for obtaining and improving land, constructing the test facilities, obtaining and installing primary test equipment, ancillary equipment, office equipment, and maintenance equipment. These items are categorized into three primary elements: building investments, land investments, and equipment costs.

Building Investments--

Building costs are obviously dependent on specific designs and features utilized. For the centralized options being considered here, a general design description was developed and submitted to the Wisconsin Department of Transportation, Bureau of Real Estate, for an assessment of the likely unit cost. The general building design calls for a clear span, metal structure, utilizing metal sandwich panel walls with normal wall and ceiling finish for the administrative areas, and no wall or ceiling finish in the inspection areas. Items such as central heating and air conditioning the administrative areas and air exchange and forced hot air heaters in the inspection area were included. No provisions were made for more specialized systems such as exhaust fume collectors; these are included in equipment costs under the general category of facility furnishings.

Based on the general design features described above, and on general size requirements, the Bureau of Real Estate estimated that the cost of constructing the buildings would be $25 per square foot. This value was used in the cost evaluations presented here.

TABLE 16. OUTLINE OF PROGRAM COST CATEGORIES AND ELEMENTS

Primary category	Principal element	Items included
I. Initial Capital Costs	1. Building investment	a. Construction cost
	2. Land investment	a. Actual land cost
		b. Pavement and landscaping
	3. Equipment costs	a. Primary test equipment
		b. Ancillary equipment
		c. Office equipment/furniture
		d. Maintenance equipment
II. One-Time Start-Up Costs	1. Land acquisition	a. Site location studies
		b. Title transfer costs
	2. Facilities planning	a. Design study
		b. Bid evaluation
		c. Construction monitoring
	3. Program design	a. Develop equipment specifications
		b. Develop subprograms (e.g., public information, surveillance, quality control, enforcement, etc.)
		c. Define personnel organizational structure
		d. Define data handling needs
		e. Plan program effectiveness studies
	4. Develop data handling systems software	
	5. Personnel training	a. Inspectors
		b. Managers
		c. Quality control personnel
		d. Mechanics training
	6. Personnel salaries and overhead prior to start-up	
	7. Initial public information program	
	8. Mechanics training program	
III. Annual Operating Costs	1. Facility personnel	a. Wages, benefits, etc.
	2. Maintenance	a. Equipment
	3. Utilities/services/supplies	a. Electric
		b. Heat
		c. Insurance
		d. Miscellaneous
		e. Taxes
IV. Annual Administrative Costs	1. Program administrative personnel	a. Wages, overhead
	2. Enforcement	
	3. Consumer protection/quality assurance	
	4. Public information	
	5. Training, licensing, certification	

It is noted here that discussions with one I/M contractor, Hamilton Test Systems, indicate that the basic building costs could be significantly more than the $25 per square foot being used in this analysis. Apparently, the general building design typically utilized by Hamilton is much more substantial than that proposed here, and the cost increases accordingly. In fact, it has been indicated that a construction cost in the range of $35 to $40 per square foot would be reasonable. In spite of these differences in cost estimated, the unit cost provided by the State was used here to represent both state and contractor operated options. This was done primarily because it is likely that the state would actually define the building specifications with regard to general type and it is assumed that the most economical design would be selected.

The Wisconsin I/M Task Force has indicated that the program will eventually be expanded to include safety and noise testing as well as the emission inspection. The buildings, therefore, are designed large enough to accommodate this expansion without additional construction. An analysis of the specific inspection tasks and equipment to be used was made to define the general features required of an inspection facility. Literature searches and interviews with individuals involved in operating similar programs resulted in defining the specific building requirements. A conceptual floor plan for the basic type of facility required for emissions, safety and noise testing is shown in Figure 10. Initially, the facilities would be used primarily for emissions testing; Figure 10, however, includes equipment that would be included when the expanded program (i.e., safety and noise testing) is fully operational. The floor plan shows a one-lane facility; building areas required for facility configurations ranging from one to six lanes are presented in Table 17.

The cost for each facility is computed as the product of (1) the building area, and (2) the unit cost, $25 per square foot. The total cost for the network is thus the sum of the costs of the individual stations shown in Table 18. The total cost for the construction of facilities, by county, is presented in Table 19; the total cost of all facilities is $5,323,375. This figure will not vary between a state owned and operated network and a contractor owned and operated system, for those reasons cited previously.

Land Investments--

A number of issues beyond the obvious one of land area are extremely crucial in estimating land costs. The basic unit cost, for example, is, in most instances, lot-specific to the extent that the per square foot cost may easily vary by a factor of three within any block; within any municipality, the unit cost may vary by a factor of ten or more. Available lots may also be limited with respect to size requirements, necessitating the purchase of lots exceeding the general requirements, or even the purchase of unwanted structures. It is obvious, then, that a precise unit cost for land cannot be provided here. Alternatively, estimates were developed by the Wisconsin Department of Transportation, Bureau of Real Estate, based on the general requirements regarding size, access, zoning, etc., for each municipality. These estimates, shown in Table 20, reflect early 1978 average market values of available, unimproved commercially zoned land located generally within a major arterial corridor. Again it must be noted that these estimates represent the average of a fairly wide range in actual unit costs.

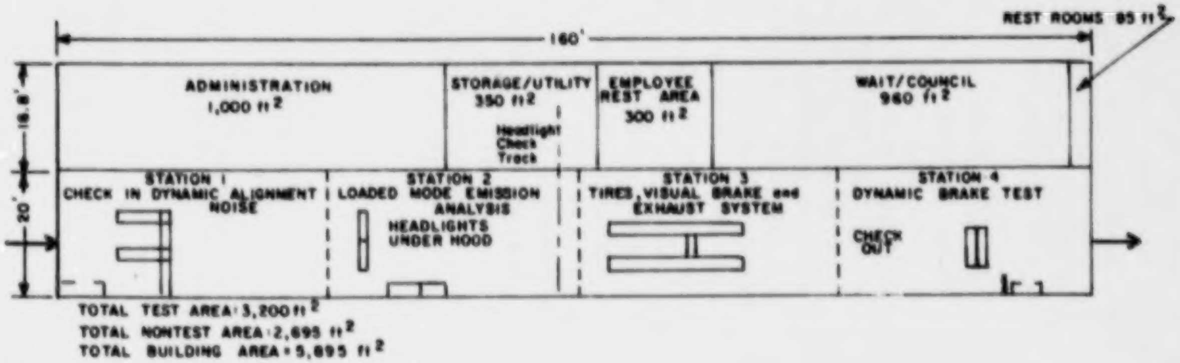
160'
REST ROOMS 85 ft²
ADMINISTRATION 1,000 ft²
STORAGE/UTILITY 350 ft²
Headlight Check Track
EMPLOYEE REST AREA 300 ft²
WAIT/COUNCIL 960 ft²
16.8'
20'
STATION 1 CHECK IN DYNAMIC ALIGNMENT NOISE
STATION 2 LOADED MODE EMISSION ANALYSIS
HEADLIGHTS UNDER HOOD
STATION 3 TIRES, VISUAL BRAKE and EXHAUST SYSTEM
STATION 4 DYNAMIC BRAKE TEST
CHECK OUT
TOTAL TEST AREA: 3,200 ft²
TOTAL NONTEST AREA: 2,695 ft²
TOTAL BUILDING AREA: 5,895 ft²

Figure 10. Conceptual floor plan for a combined safety, noise, and loaded-mode emission inspection facility.

TABLE 17. FLOOR AREA REQUIREMENTS FOR VARIOUS FACILITY CONFIGURATIONS-EMISSIONS TESTING WITH CAPABILITY TO EXPAND TO INCLUDE SAFETY AND NOISE TESTING[*]

Configuration	Floor area required, ft^2						
	Test area	Administration	Employee rest	Storage	Waiting	Rest rooms	Total
1-lane	3,200	1,000	300	350	960	85	5,895
2-lane	6,400	1,000	350	400	1,440	85	9,675
3-lane	9,600	1,000	410	450	2,240	85	13,785
4-lane	12,800	1,000	450	500	3,360	85	18,195
5-lane	16,000	1,000	500	550	4,800	85	22,935
6-lane	19,200	1,000	550	600	6,560	85	27,995

[*] Callender, J. H., Time Saver Standards for Architectural Design. McGraw-Hill. 1974.

TABLE 18. INSPECTION NETWORK REQUIREMENTS

County	Municipality	Number of facilities	Configuration, lane
Brown	Green Bay	1	4
Dane	Madison	1	4
	Madison	1	3
Kenosha	Kenosha	1	3
Milwaukee	Milwaukee	2	6
	Greenfield	1	3
Ozaukee	Meguon	1	2
Racine	Racine	1	4
Walworth	Elkhorn	1	2
Washington	West Bend	1	2
Waukesha	Brookfield	1	4
	Waukesha	1	3
Total network		13	46

TABLE 19. BUILDING COST ESTIMATES

County	Facility configuration	Per facility cost, $	Number of facilities required	Total cost, $
Brown	4-lane	454,875	1	454,875
Dane	4-lane	454,875	1	454,875
	3-lane	344,625	1	344,625
Kenosha	3-lane	344,625	1	344,625
Milwaukee	6-lane	699,875	2	1,399,750
	3-lane	344,625	1	344,625
Ozaukee	2-lane	241,875	1	241,875
Racine	4-lane	454,875	1	454,875
Walworth	2-lane	241,875	1	241,875
Washington	2-lane	241,875	1	241,875
Waukesha	4-lane	454,875	1	454,875
	3-lane	344,625	1	344,625
Total				5,323,375

TABLE 20. ESTIMATED LAND VALUES FOR COMMERCIALLY-ZONED LAND IN NINE SELECTED WISCONSIN COUNTIES

County	Municipality/area	Estimated value,* $/ft^2
Brown	Green Bay	1.70
Dane	Madison	2.00
Kenosha	Kenosha	1.70
Milwaukee	Milwaukee	1.50
	Greenfield	1.50
Ozaukee	Meguon	0.60
Racine	Racine	0.75
Walworth	Elkhorn	0.67
Washington	West Bend	0.85
Waukesha	Brookfield	2.50
	Waukesha	2.30

*Source: Wisconsin Department of Transportation, Bureau of Real Estate.

Specific lot size requirements are a function of facility configurations. A general relationship exists between land area required and test facility size. Specifically, a ratio of land area to building area can be derived based on queuing and zoning requirements; for Wisconsin, this ratio is approximately 5:1. Since building area requirements have been derived (see Table 17) land areas may be easily calculated.

Improvements to the land are also included in this category. This involves primarily pavement and landscaping. Estimates provided by the Bureau of Real Estate indicated that the unit costs for black-top paving and standard finish landscaping are approximately $0.80 per square foot and $0.25 per square foot, respectively. Total land investments, including improvements are presented in Table 21.

Equipment Costs--

The major equipment items required to operate a loaded-mode emissions test facility were identified based on analyses of inspection task requirements and conversations with individuals currently involved in these types of testing programs. It is assumed here that equipment required to perform the safety and noise aspects of the program will not be purchased until the expansion to include these inspections occurs. This will ensure that the most recent state-of-the-art equipment be purchased.

The equipment cost estimates used in this study were developed primarily from interviews with manufacturer's representatives. These interviews focused on identifying the most appropriate type and model for various major items and determining the general level of skill required to operate and maintain each. Outlined in Table 22 are the equipment requirements and associated costs for a loaded mode emission inspection program.

Equipment costs for any facility configuration, then, can be derived from Table 22. A summary of equipment costs as a function of the facility configuration is shown in Table 23.

The total network cost for equipment can be computed based on the number of facilities by configuration, developed previously. These costs, presented in detail in Table 24, total $3,179,000.

In addition to these equipment costs, three additional items must be included in the total network equipment costs; these include calibration vans and equipment, security systems, and a central computer.

One calibration van is required for each maintenance/calibration person. In Section 3, it was determined that five maintenance/calibration people would be required. The cost summary for each van is presented below:

½ ton light duty van	$ 5,500
Spare analyzer	26,500
Tools, gases, etc.	1,000
Total cost per van	$33,000

TABLE 21. ESTIMATED LAND INVESTMENT REQUIREMENTS BY COUNTY

County	Municipality	Facilities required	Configuration	Lot size per facility (ft^2)	Land cost per ft^2 ($)	Cost per facility ($)	Total cost all facilities ($)	Total queue areas (ft^2)	Total parking areas all facilities (ft^2)	Total paved areas all facilities (ft^2)	Paving cost per ft^2 ($)	Total paving cost ($)	Total landscaped area, all facilities (ft^2)	Landscaping cost per ft^2 ($)	Total landscaping cost ($)	Total improvements all facilities ($)	Total land investment all facilities ($)
Brown	Green Bay	1	4-lane	90,975	1.70	154,658	154,658	20,000	5,940	25,940	0.80	20,752	46,840	0.25	11,710	32,462	187,120
Dane	Madison	1	4-lane	90,975	2.00	181,950	181,950	20,000	5,940	25,940	0.80	20,752	46,840	0.25	11,710	32,462	214,412
	Madison	1	3-lane	68,925	2.00	137,850	137,850	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	162,484
Kenosha	Kenosha	1	3-lane	68,925	1.70	117,173	117,173	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	141,807
Milwaukee	Milwaukee	2	6-lane	139,975	1.50	209,963	419,926	60,000	17,550	77,550	0.80	62,040	146,420	0.25	36,606	98,646	518,572
	Greenfield	1	3-lane	68-925	1.50	103,388	103,388	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	128,022
Ozaukee	Mequon	1	2-lane	48,375	0.60	29,025	29,025	10,000	3,105	13,105	0.80	10,484	25,595	0.25	6,399	16,883	45,908
Racine	Racine	1	4-lane	90,975	0.75	68,231	68,231	20,000	5,940	25,940	0.80	20,752	46,840	0.25	11,710	32,462	100,693
Walworth	Elkhorn	1	2-lane	48,375	0.67	32,411	32,411	10,000	3,105	13,105	0.80	10,484	25,595	0.25	6,399	16,883	49,294
Washington	West Bend	1	2-lane	48,375	0.85	41,119	41,119	10,000	3,105	13,105	0.80	10,484	25,595	0.25	6,399	16,883	58,002
Waukesha	Brookfield	1	4-lane	90,975	2.50	227,438	227,438	20,000	5,940	25,940	0.80	20,752	46,840	0.25	11,710	32,462	259,900
	Waukesha	1	3-lane	68,925	2.30	158,528	158,528	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	183,162
							1,671,697					239,620			138,039	377,679	2,049,376

TABLE 22. MAJOR EQUIPMENT ITEMS REQUIRED FOR LOADED-MODE EMISSIONS TESTING

Program element	Item	Remarks	Unit cost ($)
I. Emissions	1. Chassis dynamometer	Needed for loaded-mode emission test. One unit per test lane required. Cost based on conversations with manufacturers (Clayton, Maxwell).	14,000
	2. Emission analyzer	Since loaded-mode is used, analyzer should be capable of measuring CO, HC, and NO_x. Extremely wide range in analyzer costs; cheaper analyzers found to be inadequate. Analyzers should be capable of being tied into computer data handling system. Costs based on discussions with manufacturers (Olson-Horiba, Hamilton Test Systems). One unit per test lane required.	26,500
II. Data System	1. CRT Terminals	Two required per lane. Costs based on literature and discussions with manufacturer's representatives (Honeywell, Digital, Olivetti, Sperry Univac), and experiences of other states.	2,500
	2. Minicomputer	One required per facility (equivalent to Digital PDP-11-05). Generally assumed to be included in the cost of facility furnishings.	80,000
III. Miscellaneous	1. Miscellaneous tools	As required.	1,000

TABLE 23. EQUIPMENT COSTS AS A FUNCTION OF FACILITY CONFIGURATION

Number of lanes	Equipment costs, $
1	126,500
2	173,000
3	219,500
4	266,000
5	312,500
6	359,000

TABLE 24. EQUIPMENT COSTS FOR LOADED MODE TESTING NETWORK

County	Municipality	Facility configuration	Number of facilities	Equipment cost per facility, $	Total cost of equipment, $
Brown	Green Bay	4-lane	1	266,000	266,000
Dane	Madison	4-lane	1	266,000	266,000
	Madison	3-lane	1	219,500	219,500
Kenosha	Kenosha	3-lane	1	219,500	219,500
Milwaukee	Milwaukee	6-lane	2	359,000	718,000
	Greenfield	3-lane	1	219,500	219,500
Ozaukee	Meguon	2-lane	1	173,000	173,000
Racine	Racine	4-lane	1	266,000	266,000
Walworth	Elkhorn	2-lane	1	173,000	173,000
Washington	West Bend	2-lane	1	173,000	173,000
Waukesha	Brookfield	4-lane	1	266,000	266,000
	Waukesha	3-lane	1	219,500	219,500
Total network					3,179,000
Calibration vans and equipment (5 @ $33,000 each)					165,000
Central computer					250,000
Security systems					14,300
Quality assurance van and equipment (1 @ $33,000)					33,000
Consumer complaints investigator's van and equipment (1 @ $33,000)					33,000
					3,674,300

In addition, the quality assurance investigator and the consumer complaint investigator would each have a calibration van and equipment at a cost of $33,000 each.

The entire network would be tied into a central computer equivalent in capability to a Digital PDP-11-35. Cost estimates were obtained from several manufacturer's representatives, including Digital, Olivetti, Honeywell, and Sperry Univac, and an average cost of approximately $250,000 was derived.

Each facility should be equipped with security systems to protect against theft and/or vandalism. A contractor has suggested a cost of $1,100 per facility for purchase and installation of security systems. This translates to a total cost of $14,300 for the entire network. The total equipment cost estimate, itemized in Table 24, is $3,674,300.

The capital costs anticipated for both the state and contractor operated options are identical, and are summarized in Table 25.

TABLE 25. INITIAL CAPITAL COST SUMMARY

Category	Item	Item cost, $	Category cost, $
Building investment	Construction	5,323,375	
			5,323,375
Land investment	Purchase	1,671,697	
	Paving	239,620	
	Landscaping	138,059	
			2,049,376
Equipment investment	Facility equipment	3,179,000	
	Calibration vans	165,000	
	Central computer	250,000	
	Security systems	14,300	
	Quality Assurance van	33,000	
	Complaint investigator's van	33,000	3,674,300
Total capital costs			11,047,051

One-Time Start-Up Costs

Implementation of an I/M program will require the expenditure of monies for non-capital items and services on a one-time basis prior to the actual start-up. Costs associated with this category are perhaps the most difficult to define at this point primarily because the elements involve services (program planning, design, development, etc.), which are inherently much more variable in cost than, for instance, equipment or building costs. Considerations used in developing cost estimates for each element are discussed with the presentation of the individual estimates as follows.

Land Aquisition--

Included in this element are the costs for identifying and locating candidate sites, negotiating purchase price, and completing title transfers. Site location and price negotiation would involve approximately 200 man-hours of professional technical time, plus 40 man-hours of professional legal time for each site. To translate man-hours to actual cost figures, a $20 per hour and $50 per hour value were assigned to technical and legal hours, respectively; this represents a total cost of $6,000 per site to cover location and negotiation. Title transfer involves physical surveys, title searches, site plan preparation, and miscellaneous support functions required to execute the purchase. The cost associated with this component is estimated to be approximately 10 percent of the unimproved land value. No difference in cost is anticipated between the state owned and contractor owned options.

For the network described previously, a total of 13 sites are required reflecting a total unimproved land investment of $1,671,697. The cost for land aquisition, then, is calculated below:

$$(13 \text{ facilities})(\$6{,}000/\text{facility}) + (0.10)(\$1{,}671{,}697)$$

$$= (\$78{,}000 + \$167{,}170) = \$245{,}170$$

Facilities Planning--

This element reflects the costs associated with engineering and design for the test facilities, bid review, and construction monitoring. Since the planning process involves bidding procedures, it is anticipated that the State would be tied to various regulations specifying the minimum number of bids it must receive and evaluate, etc. The contractor, on the other hand, may have in-house capabilities in this respect, or, at least would not be tied to the same bidding procedures as the State. In both instances the value of these services is estimated to be a function of the total building cost. Although it is difficult to quantify the State's disadvantage in this process, a value of 15 percent of the construction cost is estimated for facilities planning under a contractor system, while for the State-run option, a value of 20 percent is used. Since the total building cost is estimated to be $5,323,375, the planning cost can be calculated for both the state-run and contractor-run options as:

State-run

(0.20)($5,323,375) = $1,064,675

Contractor-run

(0.15)($5,323,375) = $798,506

Program Design--

The costs associated with program design reflect additional planning studies required to establish specific formats for the operation and administration of both the actual inspection program and adjunctive programs such as public information, mechanics training, etc. These costs are likely to be quite variable depending on factors such as the extent of in-house effort undertaken by the State. In deriving an estimate, the experiences of other states were weighed most heavily in our analysis of the likely requirements specific to Wisconsin. Based on the analysis an estimated of $100,000 was derived as the program design estimate for both contractor and state run alternatives.

Data Handling Software Development--

A comprehensive data handling software package will be required to provide both basic record keeping and program analysis functions. In developing an estimate experiences of other states, conversations with representatives of commercial data processing firms, and an analysis by our own staff were taken into consideration. Based on these discussions and our analysis of the likely requirements specific to Wisconsin, an estimate of $200,000 was developed for this element.

Personnel Training--

Personnel training will require both an ongoing effort as well as an intensive initial program to essentially train and certify the entire staff of inspectors, managerial, and maintenance/calibration personnel. A similar effort will be required to provide a mechanics training program to adequately prepare the repair industry for the maintenance phase of the program. This will be discussed separately.

To develop cost estimates for training, it was considered that a logical approach would be for the managers and assistant managers to be trained as instructors, allowing a continuation of the training program after initiation of the program without the necessity of a full time instructor. Managers would be able, then, to train any new employees themselves. The managers, also would be able to provide training for the inspectors and calibration/maintenance personnel.

Cost estimates for training were developed based on information obtained from the Colorado State University program. The estimated costs for training was found to be $53.00 for each manager and assistant manager, and $16.00 for each inspector and calibration/maintenance person.

For discussion with states and private contractors involved with the programs, the personnel requirements were derived as follows:

- One manager and one assistant manager per facility
- Three inspectors per test lane
- One maintenance/calibration person for every 10 lanes

Applying these rates to the facility requirements developed previously, the basic operating personnel requirements are:

- 13 managers
- 13 assistant managers
- 138 inspectors
- 5 maintenance/calibration persons

Using these personnel requirements and training costs derived previously, the cost of having operating personnel can be determined. This is computed as:

(13 managers)($53.00) + (13 assistant managers)($53.00)

+ (138 inspectors)($16.00) + (5 maintenance/calibration persons)($16.00)

= $3,666.00

In addition to operating personnel, the state will be required to train both a consumer complaints and a quality assurance investigator. A cost for investigator training was previously derived as $59.00. The cost of training the two individuals necessary may be calculated as follows:

(two investigators/officials)($59.00) = $118.00

The total cost, then, is the sum of the cost of training operating personnel plus the cost of training investigators, or:

$3,666.00 + $118.00 = $3,784.00

Personnel Salaries--

The costs for operating and administrative personnel were derived from "Classification and Compensation Plan" 1977 to 1978, Department of Administration, State Bureau of Personnel. Salaries were matched with position classifications most closely matching job descriptions of the positions previously defined. With one exception, salary levels used were those for "starting" personnel. The notable exception was the position of station manager. Since the managers would be involved in the many aspects of computer operation necessary in a highly automated system as was defined previously, the managers salary was assumed started at 25 percent more than the comparable position classification. Salaries, by position, are shown in Table 26.

TABLE 26. ESTIMATED HOURLY STARTING SALARIES FOR ADMINISTRATIVE AND OPERATIONAL PERSONNEL INVOLVED IN INSPECTION AND MAINTENANCE PROGRAMS IN WISCONSIN

I/M Job title	State classification	Hourly salary ($)
Administrator	Administrative officer 5	12.91
Legal counsel	Attorney (all types start at:)	7.47
Purchasing officer	Purchasing agent 1	6.54
Contracts officer		6.25
Accountants	Account examiner 1 or accountant 1	3.85 6.05
Engineer	Environmental engineer 1 or engineering technician 1	6.68 5.21
Systems analyst	Research analyst 1 or research analyst 2	5.42 5.78
Mechanic training program coordinator	Program coordinator or training officer 1	7.09 6.54
Consumer complaints investigator	Public information officer 4 or public information officer 1	7.70 4.92
Public relations coordinator	Public information officer 4	7.70
Instrument repair technician	Maintenance mechanic 3	5.91
Inspection station supervisor	Motor vehicle investigation supervisor 3	7.70
Motor vehicle inspector	Motor vehicle inspector 1	5.21

SOURCE: Bureau of Personnel
Wisconsin
(608) 266-3626

In addition to salaries, a 25 percent overhead charge was added to cover employee benefits and employee charged social security taxes.

All managerial personnel are assumed phased into the program 6 months prior to start-up; inspectors and maintenance/calibration persons are phased into the program 1 month prior to start-up.

Given the above defined phase-in and salary schedules, a total personnel cost estimate for start-up can be derived:

$$\begin{aligned}
&\Big[(13 \text{ managers})(\$1{,}667.00 \text{ per month})(6 \text{ months})\\
&+ (13 \text{ assistant managers})(\$1{,}125.00 \text{ per month})(6 \text{ months})\\
&+ (5 \text{ maintenance/calibration persons})(\$1{,}000.00 \text{ per month})(1 \text{ month})\\
&+ (138 \text{ inspectors})(\$867.00 \text{ per month})(1 \text{ month})\Big]\Big[1.25\Big]\\
&= \$428{,}028
\end{aligned}$$

The adminstrative personnel costs must also be included in the start-up phase. For the State-run option, these persons would be phased-in 24 months prior to start-up. For the contractor-run option, these persons would be phased in 12 months prior to start-up. Based on personnel requirements and salaries presented earlier, the costs associated with start-up can be computed for both the state and contractor options. These are shown in Table 27 and 28, for the state and contractor options, respectively. The total personnel cost for start-up, then, is the total of the operational personnel and administrative personnel costs, or:

State-run

$428,028 + 230,834 = $658,862

Contractor-run

$428,028 + 175,418 = $603,446

Initial Public Information Program--

The experience this far with I/M program operation indicates a definite requirement for an intensive public information effort prior to the actual start-up of the program. Based on the experiences of other states, the effort should begin approximately 12 months prior to start-up. This time requirement is discussed in greater detail in Section 4. A preimplementation budget of $0.12 per vehicle to be tested has been suggested. The average annual number of vehicles to be inspected for the period of 1982 to 1987 has been projected at approximately 1,700,000, which translates to an initial public information expenditure of $204,000.

TABLE 27. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP, STATE-RUN OPTION

Job title	Number of positions	Annual salary ($)	Participation (months)	Salary startup period ($)*
Administrator	1	25,000	24	50,000
Training officer	1	13,000	12	13,000
Legal advisor	1	15,000	6	7,500
Engineering coordinator	1	15,000	18	22,500
Systems engineer/analyst	1	11,000	1	917
Financal coordinator	1	15,000	24	30,000
Accountant	1	12,000	6	6,000
Consumer protection investigator	1	15,000	1	1,250
Quality assurance investigator	1	15,000	2	2,500
Consumer protection/quality assurance supervisor	1	15,000	12	15,000
Clerical support	2	9,000	24/each	36,000
Total salaries for 24 months				184,667
Overhead @ 25 percent				46,167
Totals	12			230,834

*Salary for participation during 24-month startup period (all positions).

TABLE 28. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP, CONTRACTOR-RUN OPTIONS

Job title	Number of positions	Annual salary ($)	Participation (months)	Salary startup period ($)*
Administrator	1	25,000	12	25,000
Training officer	1	13,000	6	6,500
Legal advisor	1	15,000	4	5,000
Engineering coordinator	1	15,000	6	7,500
Systems engineer analyst	1	11,000	1	917
Financial coordinator	1	15,000	6	7,500
Consumer protection	1	15,000	1	1,250
Quality assurance investigators	1	15,000	2	2,500
Consumer protection/qualtiy assurance supervisor	1	15,000	6	7,500
Clerical	1	9,000	12	9,000
Total salaries for state personnel				72,667
Overhead @ 25 percent				18,167
Total state cost				90,834
Contractor personnel:				
Administrator for station operations	1	25,000	12	25,000
Legal counsel	1	15,000	6	7,500
Purchasing/contracts officer	1	13,000	12	13,000
Engineer/analyst	1	11,000	12	11,000
Inspector training coordinator	1	13,000	2	2,167
Clerical	1	9,000	12	9,000
Total salaries for contractor personnel				67,667
Overhead @ 25 percent				16,917
Total contractor cost				84,584
			TOTAL COST -	175,418

*Salary for participation during 12-month startup period.

Mechanics Training Program--

A complete discussion of the anticipated mechanics training program is presented in Section 5. Based on this discussion, the cost of training mechanics was derived for three levels of participation ((1) minimum number of facilities to accommodate the vehicle population, (2) maximum number of facilities where each station would in theory reach a break-even point from revenue taken in from inspections, and (3) a midpoint value of the maximum and minimum number of facilities). For the purpose of this cost estimate, a 50 percent participation rate is assumed. This translates to a total of 1,640 dealers, repair shops, and service stations, and a cost of $36,080 (based on $22 per mechanic and one mechanic per shop). The additional two instructors will need to be trained at an estimated cost of $150 each. The total initial startup cost for the mechanics training program, then, is the total of the cost to train inspectors plus the cost to train mechanics:

$300 + $36,080 = $36,380

A summary of anticipated startup costs is presented in Table 29.

TABLE 29. SUMMARY OF STARTUP COSTS

Item	State-run option	Contractor-run Option
Land aquisition	$ 245,170	$ 245,170
Facilities planning	1,064,675	798,506
Program design	100,000	100,000
Data handling software development	200,000	200,000
Personnel training	3,784	3,784
Personnel salaries and overhead	658,862	603,446
Public information	204,000	204,000
Mechanics training	36,380	36,380
Totals	$2,512,871	$2,191,286

Annual Operating Costs

Annual operating costs include all costs associated with the actual operation of the program. For the purposes here, the costs of adjunctive programs (e.g., public information, inspection/mechanic training, etc.) are included under "Annual Administrative Costs," which are discussed later.

Facility Personnel--

Annual determinants of costs associated with the operation of the inspection facilities are: (1) the total number of individuals and relative level of job responsibility, and (2) the per-unit cost of wages and overhead.

In computing personnel costs, the personnel requirements and wage scale derived previously were employed. The per-hour wage rates for various categories were derived from data obtained from the State of Wisconsin Bureau of Personnel, Department of Administration, and the overhead estimates were based on data from the U.S. Department of Labor and State data, and from conversations with private contractors involved in operating I/M programs. The hourly overhead rate was determined to be 25 percent of the basic hourly wage rate.

Applying the facility staffing requirements and annual salaries associated with job category, the annual personnel costs can easily be computed. This estimate, shown in Table 30, is assumed the same for both the contractor-run and state-run options.

TABLE 30. ANNUAL PERSONNEL COSTS FOR FACILITY PERSONNEL

Job title	Total number of positions	Annual Salary ($)	Total annual salary for all positions ($)
Manager	13	20,000	260,000
Assistant manager	13	13,500	175,500
Calibration/maintenance	5	12,000	60,000
Inspectors	138	10,400	1,435,200
Total salaries			1,930,700
Overhead at 25%			482,675
			2,413,375

Maintenance--

Costs associated with equipment maintenance reflect equipment repair and preventive maintenance expenditures. In this connection, the yearly cost of these items was estimated to be 20 percent of the original equipment cost. Specifically, this would be:

($3,179,000)(20 percent) = $635,800

Utilities/Services/Supplies

Included in this element are the costs associated with electricity, heat, water, building services, insurance, office supplies, uniforms, inspection forms, etc. These costs were estimated based on several sources concerning equipment and facility power requirements determined from manufacturers and the general literature and the prevailing utility rates in the state, average heating requirements data for similar facilities, insurance costs and general building service requirements from existing programs.

Utilities--

Annual cost for utilities were derived from electric usages experienced by other states. For loaded-mode emission testing in the absence of safety, the rates were found to be: 120 kWh/day for each lane, and 325 kWh/day per facility. An average per kilowatt cost of $0.05 kWh was obtained from Wisconsin Power and Light. The annual cost for utilities, then, is calculated below:

(46 hours)(120 kWh/day)($0.05/kWh)(250 operating days/year)
+ (13 facilities)(325 kWh/day)($0.05/kWh)(250 operating days/year)
= $69,000 + $52,813 = $121,813 annually

Insurance--

It is assumed that the facilities would be covered by liability, fire, theft and vandalism insurance. A contractor from another state has suggested a cost of approximately $1,500/lane. Annual costs based on this estimate are calculated below:

(46 lanes)($1,500/lane) = $69,000 annually

Computer Operation--

Based on discussions with a contractor from another state, and with representatives of several data processing firms, an estimated central computer operation cost for an automated inspection system of $0.15 per test has been derived. This translates to an annual cost of $255,000 for central computer operation.

Inspection Forms--

The inspection forms serve the purpose of reporting the test results and authorizing as well as providing diagnostic information should repairs be necessary. A cost of $0.03 per test has been derived based on the experience of a contractor from another state. This computes to a total test forms cost of $51,000 annually.

Calibration Costs--

The recurring annual cost of equipment calibration, in addition to personnel salaries previously presented, is defined as the cost of calibration gases plus the operating cost of the maintenance/calibration vans. The total annual calibration costs are outlined in Table 31, and were found to be $55,000.

TABLE 31. ANNUAL CALIBRATION COSTS

Item	Cost ($)
Calibration gases (13 sets/year at $200/set)	2,600
Maintenance on van and equipment (20% of purchase price)	6,600
Operating cost ($0.15/mile, 12,000 miles)	1,800
Cost per calibration/maintenance van	11,000
Vans	5
Annually	55,000

Taxes--

Under a contractor-run option, costs for general property and real estate taxes must be included. Taxes were calculated based on full value rates for each individual municipality. General property is defined as the building value and equipment; real estate is the land plus improvement. Total annual taxes are itemized by municipality in Table 32. The "additional equipment" category includes vans and cars, the central computer, and the facilities security systems.

Uniforms--

Each facility employee is assumed to be furnished a set of uniforms. From discussions with uniform suppliers, an annual cost per employee of $125.00 was derived. This translates to a total annual cost of $21,125 for 169 uniformed employees.

The total annual cost for utilities, services, and supplies is provided in Table 33 for both the state-run and contractor-run options.

Annual Administrative Costs

Costs involved in this category reflect the overall program administrative effort. Specifically, the salaries of personnel involved in areas such as enforcement, consumer protection, public information, training, and certification are included. Also, the operating costs for quality assurance and consumer protection vehicles fall into this category.

Program Administrative Salaries and Overhead--

Annual administrative personnel costs are computed from the personnel requirements and salaries delineated previously. The annual cost computations for both the state-run and the contractor-run options are provided in Tables 34 and 35.

TABLE 32. ANNUAL TAXES - CONTRACTOR-RUN OPTION

County	Municipality	Facilities/ lanes	General property value ($)	General property tax rate*	General property tax ($)	Real estate value ($)	Real estate* tax rate	Real estate tax ($)	Total taxes annually ($)
Brown	Green Bay	1/4	720,875	0.02758	19,882	187,120	0.02317	4,336	24,218
Dane	Madison	1/4	720,875	0.03174	22,881	214,412	0.02704	5,798	28,679
	Madison	1/3	564,125	0.03174	17,905	162,484	0.02704	4,394	22,299
Kenosha	Kenosha	1/3	564,125	0.02931	16,535	141,807	0.02556	3,625	20,160
Milwaukee	Milwaukee	2/6 ea.	2,117,750	0.04270	90,428	518,572	0.03592	18,627	109,055
	Greenfield	1/3	564,125	0.02974	16,777	128,022	0.02524	3,231	20,008
Ozaukee	Mequon	1/2	414,875	0.02557	10,608	45,908	0.02236	1,027	11,635
Racine	Racine	1/4	720,875	0.03322	23,947	100,693	0.02826	2,846	26,793
Walworth	Elkhorn	1/2	414,875	0.03045	12,633	49,294	0.02594	1,279	13,912
Washington	West Bend	1/2	414,875	0.02185	9,065	58,002	0.02012	1,167	10,232
Waukesha	Brookfield	1/4	720,875	0.02531	18,245	259,900	0.02216	5,759	24,004
	Waukesha	1/3	564,125	0.02412	13,607	183,162	0.02124	3,890	17,497
Additional Equipment			495,300	0.04270**	21,149	-	-	-	21,149
Total			8,997,675	-	293,662	2,049,376	-	55,979	349,641

[*] Source: Town, Village, and City Taxes - 1976, Bulletin Nos. 176, 276 and 376 combined, Wisconsin Department of Revenue, Division of Research and Analysis, Bureau of Local Financial Assistance.

[**] Additional equipment assumed housed in Milwaukee.

TABLE 33. ANNUAL COST FOR UTILITIES, SERVICES, AND SUPPLIES - STATE VERSUS CONTRACTOR-RUN OPTIONS

Item	State-run option cost ($)	Contractor-run option cost ($)
Utilities	121,813	121,813
Insurance	69,000	69,000
Computer operation	255,000	255,000
Inspection forms	51,000	51,000
Calibration costs	55,000	55,000
Taxes	0 (exempt)	363,476
Uniforms	21,125	21,125
Total	572,938	936,414

TABLE 34. ANNUAL ADMINISTRATIVE PERSONNEL COSTS - STATE-RUN OPTION

Position	Number	Annual salary (rate) ($)	Participation (months)	Total annual salary ($)
Administrator	1	25,000	12	25,000
Training officer	1	13,000	6	6,500
Legal advisor	1	15,000	2	2,500
Systems engineer/analyst	1	11,000	12	11,000
Financial coordinator	1	15,000	12	15,000
Accountant	1	12,000	12	12,000
Consumer protection investigator	1	15,000	12	15,000
Quality assurance investigator	1	15,000	12	15,000
Consumer complaints/quality assurance supervisor	1	15,000	12	15,000
Hot-line operator	1	9,000	12	9,000
Clerical	2	9,000	12/each	18,000
Total salaries annually				144,000
Overhead @ 25 percent				36,000
TOTALS	12		128	180,000

TABLE 35. ADDITIONAL ADMINISTRATIVE PERSONNEL COSTS FOR CONTRACTOR OPTION

Position state personnel	Number	Annual salary (rate) ($)	Participation annually (months)	Total annual salary ($)
Administrator	1	25,000	12	25,000
Training officer	1	13,000	6	6,500
Systems engineer/ analyst	1	11,000	6	5,500
Financial coordinator	1	15,000	6	7,500
Consumer protection investigator	1	15,000	12	15,000
Quality assurance investigator	1	15,000	12	15,000
Consumer complaints/quality assurance supervisor	1	15,000	12	15,000
Hot-line operator	1	9,000	12	9,000
Clerical	1	9,000	12	9,000
Total state salaries				107,500
Overhead @ 25 percent				26,875
Total state cost				134,375
Administrator for station operations	1	25,000	12	25,000
Legal counsel	1	15,000	1	1,250
Purchasing/contracts officer	1	13,000	12	13,000
Engineer/analyst	1	11,000	12	11,000
Clerical	1	9,000	12	9,000
Total constractor salaries				59,000
Overhead @ 25 percent				14,750
Total contractor cost				73,750
TOTAL COST				208,125

Vehicle Operating Costs--

The Quality Assurance and Consumer Complaints investigators will each have a van equipped with an analyzer and calibration equipment. Assuming an operating cost of $0.15 per mile, and annual travel of 12,000 miles, the yearly operating cost for the two vans is:

(2 vehicles)(12,000 miles/vehicle)($0.15/mile) = $3,600

Public Information--

The actual cost of public information can only be determined by state officials on an annual basis. A contractor from another state has suggested $0.12 per vehicle to be inspected as a reasonable estimate of the anticipated expenditure. The average projected population for 1982-1987 is 1,700,000 effected vehicles, which translates to an annual public information cost of $204,000.

Personnel Training--

This element reflects the ongoing requirement to train new operating personnel. The replacement rate, number of new inspectors annually, was estimated to be 10 percent, based on experience of other states. An inspector work force of 169 was previously derived, translating to 17 new inspectors annually. The cost of training a new inspector was previously found to be $16.00, therefore the entire cost is:

17 persons at $16/person = $272.00

Summary

The total cost for both the state-run and contractor-run options are itemized in Tables 36 and 37.

FEE COMPUTATION

Annualized Costs

In order to compare costs of the two options and to devise a "break-even" fee, all costs found in Tables 36 and 37 are converted into annual figures. The steps involved in calculating these annual costs and the fees are summarized below.

Initial Capital Costs--

The primary elements associated with this category are the costs associated with land, buildings, and equipment. These costs were computed in constant 1978 dollars using appropriate amortization factors.

Since land yields services in perpetuity, the amortization factor is assumed to be the marginal rate of return on capital. This factor, then, is sensitive to the source of financing (i.e., equity, debt, or taxes). For this analysis, a factor of 0.06 is assumed.

TABLE 36. COST SUMMARY - STATE-RUN OPTION

Primary category	Principal element	Element cost ($)	Total category cost ($)
I. Initial Capital Costs	1. Building investment	5,323,375	
	2. Land investment	2,049,376	
	3. Equipment costs	3,674,300	
			11,047,051
II. One-Time Start-up Costs	1. Land acquisition	245,170	
	2. Facilities planning	1,064,675	
	3. Program design	100,000	
	4. Software development	200,000	
	5. Personnel training	3,784	
	6. Personnel salaries and overhead	658,862	
	7. Public information	204,000	
	8. Mechanics training	36,380	
			2,512,871
III. Annual Operating Costs	1. Personnel	2,413,375	
	2. Maintenance	635,800	
	3. Utilities/services/supplies	572,938	
			3,622,113
IV. Annual Administrative Costs	1. Personnel	180,000	
	2. Vehicle operation	3,600	
	3. Public information	204,000	
	4. Personnel training	272	
			387,872

TABLE 37. COST SUMMARY - CONTRACTOR-RUN OPTION

Primary category		Principal element	Element cost ($)	Total category cost ($)
I.	Initial Capital Costs	1. Building Investment	5,323,375	
		2. Land investment	2,049,376	
		3. Equipment costs	3,674,300	
				11,047,051
II.	One-Time Start-up	1. Land acquisition	245,170	
		2. Facilities planning	798,506	
		3. Program design	100,000	
		4. Software department	200,000	
		5. Personnel training	3,784	
		6. Personnel salaries and overhead	603,446	
		7. Public information	204,000	
		8. Mechanics training	36,380	
				2,191,286
III.	Annual Operating Costs	1. Personnel	2,413,375	
		2. Maintenance	635,800	
		3. Utilities/services/supplies	922,549	
				3,971,724
IV.	Annual Administrative Costs	1. Personnel	208,125	
		2. Vehicle operation	3,600	
		3. Public information	204,000	
		4. Personnel training	272	
				415,997

Structures are assumed to have a 20-year service life and to yield equal service throughout this period. The annual cost of each dollar invested in structures, then, is: $\frac{1}{1-(1+i)^{-20}}$

Similarly, equipment is assumed to provide service for 5 years, thus the annual cost per dollar invested in equipment is: $\frac{1}{1-(1+i)^{-5}}$

One-Time Startup Costs--

One-time startup costs, like capital costs, are incurred only during initial startup. The startup costs are recouped over the first 5 years of the project. Thus, the annual cost of each collar of expenditures is the same as that for capital equipment, $\frac{1}{1-(1+i)^{-5}}$

Annual Operating and Administrative Costs--

These costs are already presented as annual amounts. These amounts must be added to the annualized capital and startup costs, to arrive at the total annual cost of the whole project.

Annualized costs for each of the four categories are shown in Tables 38 and 39 for the state-run and contractor-run programs, respectively.

Effects of Inflation--

In order to eventually derive an estimate of the actual fee, which will be uniform in actual dollars over time, the effects of inflation must be considered. In this connection, it is assumed that inflation is 7 percent annually. The effect, then, is that the amortization factors used must reflect the market rate of interest, which is equal to the real rate of return on capital, (defined previously as 6 percent), plus the rate of inflation. The annualized costs, then, reflecting inflation can be computed. These are shown in Tables 40 and 41 for the state-run and the contractor-run options, respectively.

Fee Calculation

With the cost data developed above, two fees for both the state-run and contractor-run programs can be computed. The first fee, f_c, reflects the annual costs in real 1978 dollars. The second fee, f_a, in actual dollars, reflects the impact of inflation. These fees are calculated simply as the total annualized cost divided by the number of annual inspections (expected to be 1.4 million per year as the average over 5 years). The fees for both options are shown in Table 42.

TABLE 38. ANNUALIZED COSTS FOR THE STATE-RUN OPTION IN CONSTANT DOLLARS

	Cost category	Cost ($)	Amortization factor (i = 0.06)	Annualized cost ($) (column 2 × column 3)
I.	Capital costs			
	1. Land	2,049,376	0.0600	122,962
	2. Buildings	5,323,375	0.0870	463,134
	3. Equipment	3,674,300	0.2374	872,279
II.	Startup costs	2,512,871	0.2374	596,556
III.	Operating costs	3,622,113	1.0	3,622,113
IV.	Administrative costs	387,872	1.0	387,872
	Total			6,064,916

TABLE 39. ANNUALIZED COSTS FOR THE CONTRACTOR-RUN OPTION IN CONSTANT DOLLARS

	Cost category	Cost ($)	Amortization factor (i = 0.06)	Annualized cost ($) (column 2 × column 3)
I.	Capital costs			
	1. Land	2,049,376	0.0600	122,962
	2. Buildings	5,323,375	0.0870	463,134
	3. Equipment	3,674,300	0.2374	872,279
II.	Startup costs	2,191,286	0.2374	520,211
III.	Operating costs	3,971,724	1.0	3,971,724
IV.	Administrative costs	415,997	1.0	415,997
	Total			6,366,307

TABLE 40. ANNUALIZED COSTS FOR THE STATE-RUN OPTION IN ACTUAL DOLLARS

	Cost category	Cost ($)	Amortization factor (i = 0.06)	Annualized cost ($) (column 2 × column 3)
I.	Capital costs			
	1. Land	2,049,376	0.1300	266,419
	2. Buildings	5,323,375	0.1420	755,919
	3. Equipment	3,674,300	0.2840	1,043,501
II.	Startup costs	2,512,871	0.2840	713,655
III.	Operating costs	3,622,113	1.2100	4,382,757
IV.	Administrative costs	387,872	1.2100	469,325
	Total			7,631,576

TABLE 41. ANNUALIZED COSTS FOR THE CONTRACTOR-RUN OPTION IN ACTUAL DOLLARS

	Cost category	Cost ($)	Amortization factor (i = 0.06)	Annualized cost ($) (column 2 × column 3)
I.	Capital costs			
	1. Land	2,049,376	0.1300	266,419
	2. Buildings	5,323,375	0.1420	755,919
	3. Equipment	3,674,300	0.2840	1,043,501
II.	Startup costs	2,191,286	0.2840	622,325
III.	Operating costs	3,971,724	1.2100	4,805,786
IV.	Administrative costs	415,997	1.2100	503,356
	Total			7,997,306

TABLE 42. BREAK-EVEN FEES, f_c, IN REAL 1978 DOLLARS, AND f_a IN ACTUAL DOLLARS FOR THE STATE-RUN AND CONTRACTOR-RUN OPTIONS

Option	Fee in real dollars	Fee in actual dollars
State-run	4.33	5.45
Contractor-run	4.54	5.71

Cost Schedule

From the implementation schedule derived in Section 8, cost schedules were defined for both the state-run and the contractor-run options; these schedules are provided in Tables 43 and 44, respectively. Capital costs for land, buildings and equipment expenditures are anticipated to occur during 1980. Startup costs are spread evenly over the startup period, 2 years for the state-run option, 1 year for the contractor-run program. Annual operating and administrative costs begin with the mandatory inspection phase during 1981, as do revenues. For the contractor, costs begin to be incurred during January 1981, while for a state-run program, cost demand begins in mid-1981. For the state approach then, only 6 months of annual operating and administrative costs and revenues are assumed for 1981. Registration projections derived previously, and a $5.00 fee were assumed in determining the annual revenues.

Accumulative costs were compared to accumulative revenues for the period 1979 to 1987. As can be seen from Tables 43 and 44, a significant deficit occurs until 1986 in the state-run option and 1987 in the contractor option. These summaries may be somewhat misleading, however. Although the capital costs of buildings and land were considered as debits, it must be assumed that both would maintain some residual value; that is, at any time, the initial investment (presumably plus interest at least equal to the rate of inflation) could be recouped through the sale of the facilities. Even with a very conservative assumption that the facilities have a residual value equal to 80 percent of the original cost after 5 years (in 1985), the break-even point would be reached.

TABLE 43. COST SCHEDULE FOR A STATE-RUN PROGRAM, 1979-1987

Year	Cost category				Accumulative total costs ($)	Accumulative total revenue ($)*	Surplus/deficit
	Capital ($)	Startup ($)	Annual operating ($)	Administrative ($)			
1979	0	628,218	0	0	628,218	0	-628,218
1980	11,047,051	1,256,435	0	0	12,931,704	0	-12,931,704
1981	0	628,281	1,811,057	193,936	15,564,915	3,186,695	-12,378,220
1982	0	0	3,622,113	387,872	19,574,900	9,716,695	-9,858,205
1983	0	0	3,622,113	387,872	23,584,885	16,411,195	-7,173,630
1984	0	0	3,622,113	387,872	27,594,870	23,274,345	-4,320,525
1985	0	0	3,622,113	387,872	31,604,855	30,310,345	-1,294,510
1986	0	0	3,622,113	387,872	35,614,840	37,523,635	+1,908,795
1987	0	0	3,622,113	387,872	39,624,825	44,918,635	+5,293,810
Total	11,047,051	2,512,871	23,543,735	2,521,168	39,624,825	44,918,635	+5,293,810

*Assumes $5.00 fee. All figures in constant 1978 dollars.

TABLE 44. COST SCHEDULE FOR A CONTRACTOR-RUN PROGRAM, 1979-1987

Year	Cost category				Accumulative total costs ($)	Accumulative total revenue ($)	Surplus/deficit
	Capital ($)	Startup ($)	Annual operating ($)	Administrative ($)			
1979	7,372,751	0	0	0	7,732,751	0	-7,342,751
1980	3,674,300	2,191,286	0	0	13,238,337	0	-13,238,337
1981	0	0	3,971,724	415,997	17,626,058	6,373,390	-11,252,668
1982	0	0	3,971,724	415,997	22,013,779	12,903,390	-9,110,389
1983	0	0	3,971,724	415,997	26,401,500	19,597,890	-6,803,610
1984	0	0	3,971,724	415,997	30,789,221	26,461,040	-4,328,181
1985	0	0	3,971,724	415,997	35,176,942	33,497,040	-1,679,902
1986	0	0	3,971,724	415,997	39,564,663	40,710,330	+1,145,667
1987	0	0	3,971,724	415,997	43,952,384	48,105,330	+4,152,946
Total	11,047,051	2,191,286	27,802,068	2,911,979	43,952,384	48,105,330	+4,152,946

SECTION 8

IMPLEMENTATION PLANNING

INTRODUCTION

Owing to the nature of inspection and maintenance (I/M) programs, the implementation planning phase is extremely crucial with regard to overall program success. Implementation planning can be discussed in terms of coordinating and scheduling various efforts and activities such as securing necessary legislation and funds, selecting the particular operating mode (State-run or Contractor-operated), arranging for the selection of a contractor(s) to run and/or design the inspection facilities, etc., in other words, coordinating all efforts aimed at getting the program from the conceptual stage to the operational phase. With regard to program success, a distinction can be made between success in terms of (1) accomplishing all those tasks that result in the program being operational by a specified deadline and designed and constructed to operate efficiently, etc.; and (2) the public's acceptance and recognition of the program as an important mechanism for achieving a cleaner environment. The types of planning that will enhance the success of the program in terms of the first definition concern physical planning (e.g., construction planning) while in terms of success from the viewpoint of public acceptance, the critical planning areas consider policy planning (e.g., gradual implementation, gradually increasing stringency factors, planning public information programs; in other words, planning activity that focuses on "selling" the program to the public). Both types of planning are considered in the following paragraphs.

In view of the relative importance of issues concerning scheduling and phase-in, it is appropriate to provide a discussion of these issues; it is not with the intention of deriving a detailed schedule for the implementation of the program, rather the purpose here is to provide an indication of some of the most critical factors in the scheduling and phase-in processes.

In this connection, three general types of issues can be considered. First, the U.S. Environmental Protection Agency has set policy guidelines that directly affect the schedule and phase-in requirements of the program. These concern primarily the dates when the program has to be implemented and operating fully. Second, there exists a general sequence to the efforts that will be undertaken in connection with implementing the program that, even though quite logical and perhaps very obvious, will be mentioned here for completeness. Third, there are several issues relating to either scheduling or phase-in that are quite subtle and have a potential impact on the program. These types of issues have been identified through discussions with individuals who have been involved in the implementation and/or operation of I/M programs and have the insights that are obviously gained through such experience.

IMMEDIATE ISSUES

The most immediate issues are those that require action of some sort by EPA, either in connection with the revised State Implementation Plan (SIP) or as a matter concerning the I/M program specifically. In that the I/M program is an element in the SIP, there is obviously a strong connection between SIP requirements and the tasks that must be accomplished immediately as part of the I/M effort. With regard to scheduling, EPA guidance defines several requirements concerning I/M that must be fulfilled prior to submitting the revised SIP; these can be seen in the following excerpt from an EPA policy memorandum dated 17 July 1978:

> "The I/M Implementation Schedule
>
> The specific items listed below must be included as a part of the States' I/M implementation schedules with specified dates for implementation of each item. The stringency planned for the program and other factors affecting the potential for emission reductions should also be indicated. Additional items if necessary because of local factors may be required by U.S. EPA Regional Offices.
>
> 1. Initiation (or continuation) of public information program including publicizing the I/M program in the media, meeting and speaking with affected interest groups, etc.
> 2. Preparation of a draft legislative package and submittal of legislation package to legislature if additional legislative authority is needed.
> 3. Certification of adequate legal authority by appropriate state official.
> 4. Initial notification of garages explaining program and schedule of implementation.*
> 5. Development and issuance of RFPs.*
> 6. Award to contractor(s).*
> 7. Initiation of construction of facilities.*
> 8. Completion of construction of facilities.*
> 9. Adoption of procedures and guidelines for testing and quality control including emission analyzer requirements (and licensing requirements for private garages, if applicable).*

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*Indicates that items may apply to some I/M programs and not to others.

10. Notification of and explanation to garages of actions in Step 9.*

11. Completion of equipment specification, and purchase and delivery of equipment.

12. Development and adoption of cutpoints.

13. Initiation of hiring and training of inspectors or licensing of garages.*

14. Initiation of introductory program (voluntary maintenance with either voluntary or mandatory inspection) if not previously initiated.

15. Initiation of mechanics training and/or information program.

16. Initiation of mandatory inspection.

17. Initiation of mandatory repair for failed vehicles.

If certification of adequate legal authority occurs after January 1979, the States may modify previous commitments to implement and enforce the elements of the schedule to conform to the legal authority.* These modifications will be approved by the EPA Regional Offices and must be consistent with the Administrator's February 24, 1978, policy memorandum. The documents should be submitted by January 1, 1979. Any necessary adjustments to the schedule may be made at this time but must be approved by the EPA Regional Offices."

The requirement is that an I/M implementation schedule be prepared as part of the SIP revision, and that the schedule consider the items listed above (if applicable). The development of this section considers the above list of schedule elements as well as several additional elements, and these are discussed below. The discussion of each element should provide some insight as to how the I/M schedule requirement (defined above) should be addressed. However, the basic task is:

- formulate tentative plans for the format, scope, design operation and implementation of the items listed in the I/M Schedule requirements; this has to be accomplished by 30 November 1978.

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*Indicates that items may apply to some I/M programs and not to others.

which is followed by a second task involving:

- develop an I/M implementation schedule that will address (at least) the relevant issues defined[*] above for submittal as part of the revised SIP; this has to be completed prior to 31 December 1978.

A good starting point in this discussion concerns the legislative requirements indicated by Items 2 and 3 in the Implementation Scheduling requirements.

At this point, the specific I/M program scenario that will be implemented in Wisconsin has been defined except for the operating agency whether it will be a State-run program or contractor-run. Some differences exist in the issues relating to scheduling depending on the operating mode selected, therefore issues discussed here will include those that are common to both operating modes as well as those peculiar to one or the other.

As a general comment, the implementation requirements are such that a cogent planning effort should be underway even at this point in time to ensure that the schedule requirements (discussed later) can be met. That the State recognizes this requirement is obvious in that an I/M Interagency Task Force has been established and is actively dealing with the matter of I/M in Wisconsin. Several, rather crucial decisions must be made by the Task Force (or, by those State officials represented directly by the Task Force) that will directly affect the direction that the program effort will take. These decisions concern issues such as whether the inspection facilities will be State or contractor run, who will be responsible for the design and implementation of various supporting programs (e.g., public information, mechanic's training, etc.), and others. Perhaps the most crucial decisions are those that are yet to be made concerning various technical and administrative issues, particularly those that have to be included in the enabling legislation (see Section 6). These are of fundamental concern because the enabling legislation must be drafted fairly soon since the State Legislature convenes next in January 1979 for a 2-month session and, in order to meet the EPA deadline of 31 June 1979 for securing the legal authority to implement and enforce the program, must be ratified during this session. The basic tasks indicated and the time frame for their completion, then, are:

- define remaining technical and administrative aspects of the program that are necessary to be included in the enabling legislation; this should be accomplished by 30 November 1978.

- prepare enabling legislation; this should be completed during December 1978.

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[*] To eliminate confusion, it should be stated at the outset that Items 4 and 10 in the Implementation Schedule elements are not required for the option selected by the States and, therefore, will not be discussed here.

In a very similar connection, a program budget must be derived in order to secure the funds necessary to implement and operate the program. This establishment of the required funds is also a legislative process and, therefore, must also occur during the early 1979 State Legislative Session. This obviously requires the preparation of a budget estimate and substantiating documentation, probably by the I/M Task Force. The specific task, then is:

- prepare program budget request including actual estimates and substantiating data; this should be accomplished prior to 1 January 1979.

To carry this discussion a step further, the legislation and budget must be approved by the State Legislature as a prerequisite for the advancement of the program beyond the conceptual stage. It is unfortunate that there are no checklists that can be followed or procedures that can be recommended to guarantee rapid approval of the proposed legislation and budget by the State Legislature. EPA guidance, however, is rather specific with regard to the scheduling requirements for securing the proper authority to implement I/M, as can be seen in the following excerpt from an EPA policy memorandum dated 17 July 1978:

> "Authority to Implement I/M
>
> Normally, adequate legal authority to implement a SIP revision must exist for a revision to be approved. Where a legislature has had adequate opportunity to adopt enabling legislation before January 1, 1979, the Regional Administrator should require certification that adequate legal authority exists for I/M implementation by January 1, 1979. However, for many states there will be insufficient opportunity to obtain adequate legal authority before their legislatures meet in early 1979. Therefore, a certification of legal authority for the implementation of I/M in these states must be made no later than June 30, 1979. An extension to July 1, 1980, is possible, but only when the state can demonstrate that (a) there was insufficient opportunity to conduct necessary technical analyses and/or (b) the legislature has had no opportunity to consider any necessary enabling legislation for inspection/maintenance between enactment of the 1977 Amendments to the Act and June 30, 1979. Certification of adequate legal authority, or other evidence that legal authority has been adopted, must be submitted to the EPA Regional Offices to be included in the SIP revision already submitted. Failure to submit evidence of legal authority by the appropriate deadline will constitute a failure to submit an essential element of the SIP, under Sections 110(a)(2)(I) and 176(a) of the Act."

It is entirely likely (and logical) that during discussion regarding the I/M legislation the question will arise as to: what will happen if we do not approve I/M legislation by the 31 June 1979 deadline? The answer to this is that the State would not be able to submit an essential element of the SIP, and that Sections 110(a)(2)(I) and 176(a) of the Act would apply. Of particular interest are the provisions of Section 176(a), which deal with sanctions that may be placed against states for noncompliance; this Section is excerpted below:

LIMITATIONS ON CERTAIN FEDERAL ASSISTANCE

SEC. 176. (a) The Administrator shall not approve any projects or award any grants authorized by this Act and the Secretary of Transportation shall not approve any projects or award any grants under title 23, United States Code, other than for safety, mass transit, or transportation improvement projects related to air quality improvement or maintenance, in any air quality control region—

(1) in which any national primary ambient air quality standard has not been attained,

(2) where transportation control measures are necessary for the attainment of such standard, and

(3) where the Administrator finds after July 1, 1979, that the Governor has not submitted an implementation plan which considers each of the elements required by section 172 or that reasonable efforts toward submitting such an implementation plan are not being made (or, after July 1, 1982, in the case of an implementation plan revision required under section 172 to be submitted before July 1, 1982).

(b) In any area in which the State or, as the case may be, the general purpose local government or governments or any regional agency designated by such general purpose local governments for such purpose, is not implementing any requirement of an approved or promulgated plan under section 110, including any requirement for a revised implementation plan under this part, the Administrator shall not make any grants under this Act.

(c) No department, agency, or instrumentality of the Federal Government shall (1) engage in, (2) support in any way or provide financial assistance for, (3) license or permit, or (4) approve, any activity which does not conform to a plan after it has been approved or promulgated under section 110. No metropolitan planning organization designated under section 134 of title 23, United States Code, shall give its approval to any project, program, or plan which does not conform to a plan approved or promulgated under section 110. The assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency, or instrumentality.

(d) Each department, agency, or instrumentality of the Federal Government having authority to conduct or support any program with air-quality related transportation consequences shall give priority in the exercise of such authority, consistent with statutory requirements for allocation among States or other jurisdictions, to the implementation of those portions of plans prepared under this section to achieve and maintain the national primary ambient air quality standard. This paragraph extends to, but is not limited to, authority exercised under the Urban Mass Transportation Act, title 23 of the United States Code, and the Housing and Urban Development Act.

The implications of not approving I/M legislation are quite severe, as can be seen from Section 176(a), and therefore should be considered in legislative discussions on the proposed legislation.

The basic task, then, is:

- approve I/M legislation and corresponding funding; this in general should be accomplished prior to 31 June 1979, but considering the dates that the Legislature is in session, approval should occur during January or February 1979.

The second element to be discussed concerns the initiation of a public information program regarding I/M. In deciding on the particular program details, several points should be considered. First, there are three basic stages in the public information effort and the activity and timing of each should be treated carefully. The first stage occurs during the period prior to introducing the legislation to the Legislature, and extends through the time that the legislation is approved. The intent is to inform the public about the basic concepts of the program primarily to develop support from those individuals whose representatives will be acting on the legislation in the State Legislature. The effort may be directed more toward organized groups who have both a recognized lobbying power and an inherent interest in promoting air pollution reduction. The second phase occurs approximately 6 months to a year prior to the start-up of the program and extends through the first year of operation. This entails a very strong, visible effort to inform the public about the details of the I/M program, particularly concerning the benefits that the individual motorist is likely to derive from the program. Also, the intent should be to ensure that the requirements for each motorist to obtain an inspection are defined in detail so that essentially everyone knows what to expect with regard to how he is notified as to when and where he will be inspected, eliminate uncertainty regarding repair liability (repair cost ceiling), where he can take his vehicle for repairs if required, etc. The final phase is a continued effort after the I/M program is operating smoothly. The intent would be to inform the public of the program's effectiveness in reducing pollution. This would require a somewhat lower level of effort than would the second stage.

The tasks associated with public information programs, then, can be described as follows:

- develop program strategy including who will operate the program (State franchise or private firm), level of activity associated with each phase, implementation dates (approximate) of each phase, etc.; this planning effort should be completed prior to 31 November 1978.

- define details of the first phase of the public information program and implement and conduct same; this should occur during the period from approximately 1 November 1978 to 1 March 1979 (or until legislation is adopted.

- define details of the second phase of the public information program and implement and conduct same; this should begin 6 to 12 months prior to program start-up and extend through the first year of full operation.

- define details of the third phase of the public information program and implement and conduct same; this should follow the completion of the second phase and continue as required.

The public information programs and schedules described above are the same for both State-run and contractor-run options.

The next items from the list of I/M Implementation Schedule elements that will be discussed are items 5, 6, 7, and 8; items 5 and 6 deal specifically with the contractor option while 7 and 8 deal with either State-run or contractor-run programs. Specifically, items 5 and 6 concern developing and issuing requests for proposals (RFP's), and subsequent award of a contract(s) to a private firm, while items 7 and 8 concern the construction of facilities, which is a required step regardless of who operates the program. The basic condition of who is to operate the program must be defined at the outset. This obviously has to be completed during the initial program planning prior to 30 November 1978.

Assuming first that contractor-operated inspection facilities are selected, the first task would be to develop a detailed plan of what the program is to include, and specifically, what the requirements for and responsibilities of the contractor would be. These would be published as an RFP and distributed to interested contractors, who would respond with proposal to establish and operate the inspection facilities. The State would review and evaluate the proposals and select a particular contractor from those submitting proposals.

The next items deal with the initiation and completion of facilities construction. If the State-run option is selected, an additional task can be identified and that concerns developing building designs, soliciting bids from a (construction) contractor, and finally selecting a construction contractor. Also, certain other steps are also as critical as construction start and completion dates, such as site selection and land purchases, etc.

The individual tasks associated with these items can be defined as follows:

- select operating agency in terms of State-run or contractor-run; this has to be done prior to 30 November 1978.

Contractor-run:

- prepare request for proposal; this would likely take 2 months to prepare and would not be started until after the legislature and budget were approved; this task would occur, then say during April and May 1979; this task would be accomplished only for a contractor-run option.

- assuming that the RFP's were issued during June 1979 and proposals due in early July 1979, the proposals could be evaluated and a contractor selected by September 1979.

- contractor begins site search and purchases required land; occurs during the period October 1979 through March 1980.

- contractor begins construction of facilities; construction period May 1980 through December 1980.

State-run:

- if the State-run option is selected, a design/construction contractor is required; preparation of invitation to bid is required; this would occur after legislation and budget were approved, say during April 1979.

- again, for State-run option, the bids for design/construction would be evaluated and a contractor selected; this would occur during June and July 1979.

- for State-run option, land investigation would precede site selection; negotiation and purchase would occur during period from July 1979 through March 1980.

- design plans would be developed for State-run option; this would occur during the period August 1979 to August 1980.

- construction on State-run facilities begins; construction period August 1980 to May 1981.

Selection, purchase, and delivery of equipment is listed next in the I/M Implementation Schedule. It could be expected that a fairly substantial lead time would be required between ordering and delivery of certain equipment items. The intent, however, would be to stage equipment delivery over the latter portion of the facilities construction period, so that equipment could be installed as it arrives. This is the usual procedure used in construction practice and should not be of extraordinary concern. Some time savings in equipment purchase may be possible with the contractor option source competitive bidding would not be required. The tasks involved here are as follows:

- Contractor Option:

    - Select equipment in accordance with State specifications, purchase same; this would be done, say, during the period May through December 1980.

    - Equipment delivery; occurs as required May through December 1980.

- State-Run Option:
  - Advertise for bids; occurs during period August 1980.
  - Select equipment suppliers, schedule deliveries; occurs during the period September 1980 to August 1981.

Item 12 in the Implementation Schedule concerns the development and adoption of cutpoints. Initial cutpoints can be selected based on vehicle emissions data compiled by other states, and these can be refined during the early stages of inspection once a sufficient cross-section of the vehicle population has been tested. The initial cutpoints should be defined after some initial study of existing data. Specific tasks include:

- review data from other programs, define initial cutpoints; this can take place during the period 6 to 9 months prior to startup;
- refine cutpoints to account for Wisconsin-specific data and changing vehicle emissions characteristics; this occurs approximately 6 months after initiation of testing and continues throughout program.

Items 13 and 15 on the Implementation Schedule deal with hiring and training impactors and other personnel, and initiation of training programs for both inspection personnel and the auto, repair industry. A distinction can be made with regard to operating personnel and administrative personnel phase in. Administrative personnel would be phased into the program 24 months prior to beginning the testing while operating personnel, managers and inspectors, would be phased in 6 months and 1 month prior to startup, respectively. No differences in operating personnel phase-in occurs between the state- and contractor-run options. Training courses for inspection personnel would begin approximately 6 months prior to startup to train all new personnel, and the training would continue throughout the program to train additional personnel being brought into the system. The mechanics training program would begin approximately 6 months prior to mandatory maintenance. A task that must be carried out prior to implementing mechanic training is to define the nature of the training program in terms of who will do the testing, what will be taught, etc. The specific tasks involved include:

- hire administrative personnel; this would be accomplished 24 months prior to program start-up. (For state-run option; 12 months for contractor-run option.)
- hire inspection facility managers and assistant managers; this would be accomplished 6 months prior to start;
- determine training program details including scope, who will conduct training, where training is to be held, etc., this would be accomplished 1 year prior to start-up.
- begin mechanics/inspector training program; this would begin 6 months prior to beginning any testing (inspector training phase would begin 1 month prior to start-up).

The last items on the Implementation Schedule concern phasing in mandatory inspections and mandatory maintenance. Although the Task Force has indicated that the general procedure would be to have voluntary maintenance but mandatory inspections during the first full year of operation, this proposal should be reconsidered in view of the requirements for implementing mandatory I/M set forth in the EPA guidance. The specific guidance on deadlines is provided below:

> D. "I/M Implementation Deadlines
>
> Implementation of I/M "as expeditiously as practicable" shall be defined as implementation of mandatory repair for failed vehicles no later than two and a half years after passage of needed legislation or certification of adequate legal authority for new centralized systems and one and a half years after legislation or certification for decentralized systems or for centralized systems which are adding emission inspections to safety inspections. For the normal legislation deadline of June 30, 1979, new centralized programs must start by December 31, 1981, and all others must start by December 31, 1980. For the case of the latest possible legislation date, July 1, 1980, this means that a new centralized program must start by December 31, 1982, while all other programs must start by December 31, 1981. Where I/M can be implemented more expeditiously, it must be. Each state implementation schedule must be looked at individually to determine if it is as expeditious as practicable. Implementation dates ordered by courts, if earlier than these dates, take precedence."

It appears that there would be a chance for a full year of mandatory inspection, voluntary maintenance if the contractor option is selected and implementation procedures generally along the schedule indicated up to this points, which calls for start-up to begin in January 1981. Since the State-run option would require approximately 6 additional months bringing start-up to July 1981.

The tasks that can be identified here regarding phase-in are:

- For State-Run Option:
  - implement mandatory inspection, voluntary maintenance; this would occur approximately July 1981 and run through 31 December 1981.
  - implement mandatory inspection, mandatory maintenance; this would begin 31 December and continue throughout the program.

- For Contractor-Run Option:
  - implement mandatory inspection, voluntary maintenance; this will occur approximately 1 January 1981 and run through 31 December 1981.
  - implement mandatory inspection, mandatory maintenance; this would begin 1 January 1982 and extend throughout the program.*

The issues discussed above, again, must be defined in terms of the schedule for implementation in the revised SIP. As a summary of the above discussion, Table 45 is presented showing each task identified above and its approximate implementation date.

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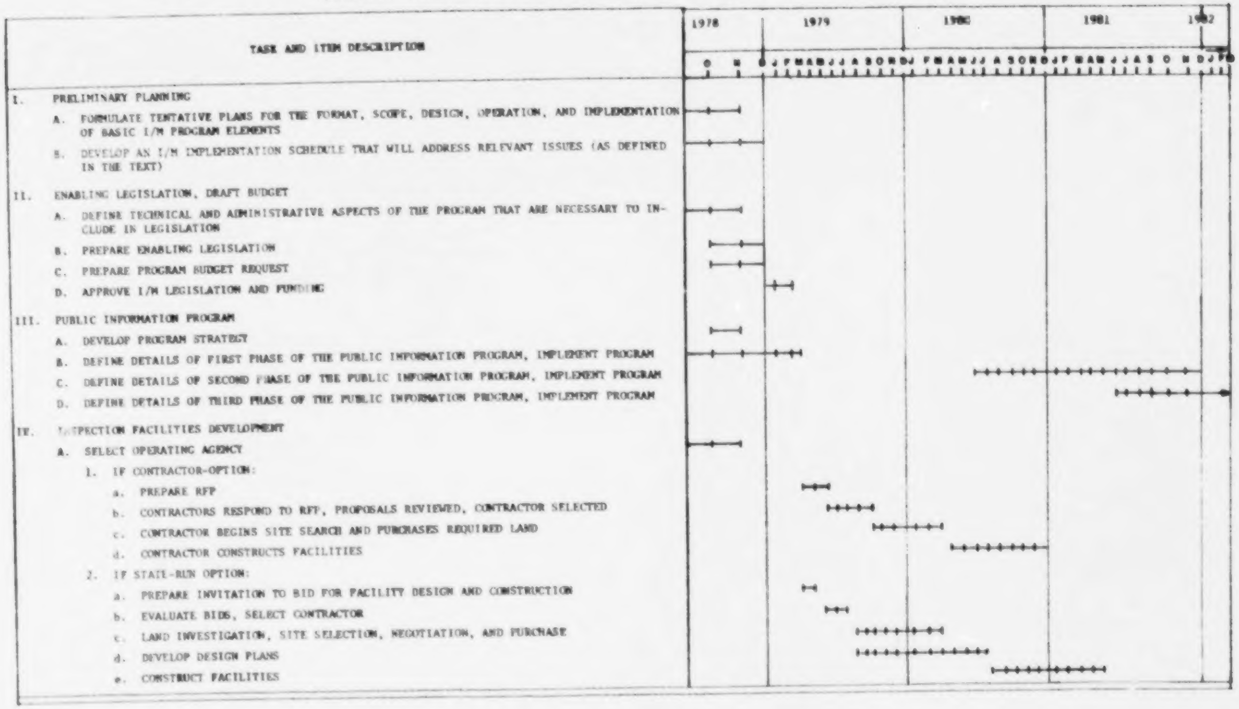
*The actual duration of the program beyond 1987 is open to speculation at this time. Should the program not be needed as an air quality improvement measure beyond 1987, the state would have the option of continuing, modifying, or terminating it

TABLE 45. IMPLEMENTATION SCHEDULE - SUMMARY



TASK AND ITEM DESCRIPTION

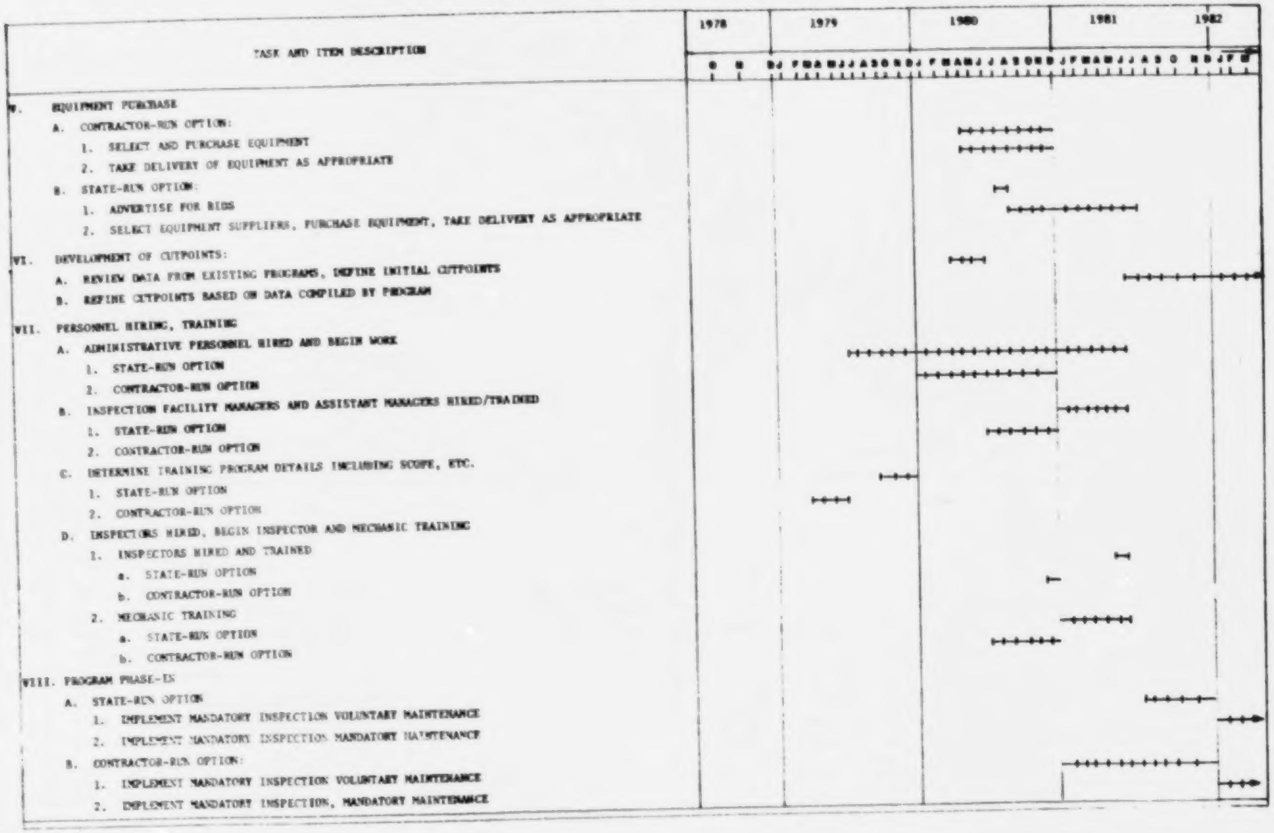
I. PRELIMINARY PLANNING
  - A. FORMULATE TENTATIVE PLANS FOR THE FORMAT, SCOPE, DESIGN, OPERATION, AND IMPLEMENTATION OF BASIC I/M PROGRAM ELEMENTS
  - B. DEVELOP AN I/M IMPLEMENTATION SCHEDULE THAT WILL ADDRESS RELEVANT ISSUES (AS DEFINED IN THE TEXT)

II. ENABLING LEGISLATION, DRAFT BUDGET
  - A. DEFINE TECHNICAL AND ADMINISTRATIVE ASPECTS OF THE PROGRAM THAT ARE NECESSARY TO INCLUDE IN LEGISLATION
  - B. PREPARE ENABLING LEGISLATION
  - C. PREPARE PROGRAM BUDGET REQUEST
  - D. APPROVE I/M LEGISLATION AND FUNDING

III. PUBLIC INFORMATION PROGRAM
  - A. DEVELOP PROGRAM STRATEGY
  - B. DEFINE DETAILS OF FIRST PHASE OF THE PUBLIC INFORMATION PROGRAM, IMPLEMENT PROGRAM
  - C. DEFINE DETAILS OF SECOND PHASE OF THE PUBLIC INFORMATION PROGRAM, IMPLEMENT PROGRAM
  - D. DEFINE DETAILS OF THIRD PHASE OF THE PUBLIC INFORMATION PROGRAM, IMPLEMENT PROGRAM

IV. INSPECTION FACILITIES DEVELOPMENT
  - A. SELECT OPERATING AGENCY
    - 1. IF CONTRACTOR-OPTION:
      - a. PREPARE RFP
      - b. CONTRACTORS RESPOND TO RFP, PROPOSALS REVIEWED, CONTRACTOR SELECTED
      - c. CONTRACTOR BEGINS SITE SEARCH AND PURCHASES REQUIRED LAND
      - d. CONTRACTOR CONSTRUCTS FACILITIES
    - 2. IF STATE-RUN OPTION:
      - a. PREPARE INVITATION TO BID FOR FACILITY DESIGN AND CONSTRUCTION
      - b. EVALUATE BIDS, SELECT CONTRACTOR
      - c. LAND INVESTIGATION, SITE SELECTION, NEGOTIATION, AND PURCHASE
      - d. DEVELOP DESIGN PLANS
      - e. CONSTRUCT FACILITIES

TABLE 45 (continued)



TASK AND ITEM DESCRIPTION

V. EQUIPMENT PURCHASE
- A. CONTRACTOR-RUN OPTION:
  - 1. SELECT AND PURCHASE EQUIPMENT
  - 2. TAKE DELIVERY OF EQUIPMENT AS APPROPRIATE
- B. STATE-RUN OPTION:
  - 1. ADVERTISE FOR BIDS
  - 2. SELECT EQUIPMENT SUPPLIERS, PURCHASE EQUIPMENT, TAKE DELIVERY AS APPROPRIATE

VI. DEVELOPMENT OF CUTPOINTS:
- A. REVIEW DATA FROM EXISTING PROGRAMS, DEFINE INITIAL CUTPOINTS
- B. REFINE CUTPOINTS BASED ON DATA COMPILED BY PROGRAM

VII. PERSONNEL HIRING, TRAINING
- A. ADMINISTRATIVE PERSONNEL HIRED AND BEGIN WORK
  - 1. STATE-RUN OPTION
  - 2. CONTRACTOR-RUN OPTION
- B. INSPECTION FACILITY MANAGERS AND ASSISTANT MANAGERS HIRED/TRAINED
  - 1. STATE-RUN OPTION
  - 2. CONTRACTOR-RUN OPTION
- C. DETERMINE TRAINING PROGRAM DETAILS INCLUDING SCOPE, ETC.
  - 1. STATE-RUN OPTION
  - 2. CONTRACTOR-RUN OPTION
- D. INSPECTORS HIRED, BEGIN INSPECTOR AND MECHANIC TRAINING
  - 1. INSPECTORS HIRED AND TRAINED
    - a. STATE-RUN OPTION
    - b. CONTRACTOR-RUN OPTION
  - 2. MECHANIC TRAINING
    - a. STATE-RUN OPTION
    - b. CONTRACTOR-RUN OPTION

VIII. PROGRAM PHASE-IN
- A. STATE-RUN OPTION
  - 1. IMPLEMENT MANDATORY INSPECTION VOLUNTARY MAINTENANCE
  - 2. IMPLEMENT MANDATORY INSPECTION MANDATORY MAINTENANCE
- B. CONTRACTOR-RUN OPTION:
  - 1. IMPLEMENT MANDATORY INSPECTION VOLUNTARY MAINTENANCE
  - 2. IMPLEMENT MANDATORY INSPECTION, MANDATORY MAINTENANCE

SECTION 9

SUMMARY AND CONCLUSIONS

INTRODUCTION

Need for Inspection and Maintenance Program

Amendments to the Clean Air Act that were adopted during 1977 have established that the National Ambient Air Quality Standards (NAAQS) for pollutants such as carbon monoxide (CO) and photochemical oxidants (O_x) must be attained in all areas of the U.S. no later than 31 December 1982. The U.S. Environmental Protection Agency, the federal agency charged with the responsibility of administering and enforcing the Clean Air Act and amendments thereto, has set the requirement that each state containing an area (or areas) currently in violation of the NAAQS must submit a revision to its State Implementation Plan (SIP) during January 1979 demonstrating compliance in all areas by 31 December 1982. That all states will not be able to demonstrate total compliance by the end of 1982 is recognized in the Amendments and provisions are made for extending the compliance date to 31 December 1987. In order to obtain the extension, however, the revised SIP to be submitted in January 1979 must include (among other things) a specific schedule for the implementation of a motor vehicle emissions inspection and maintenance (I/M) program in those nonattainment areas that have an urbanized population greater than 200,000. Failure to submit an acceptable I/M schedule (or if a reasonable effort toward submitting an acceptable schedule is not being made) will result in rather severe sanctions being imposed on the state.

Preliminary reviews of the status of air quality control regions in the State of Wisconsin have indicated that the NAAQS for O_x and/or CO will likely not be achieved by 31 December 1982 in all instances. Given the requirements of the Clean Air Act Amendments mentioned above, a decision was made to initiate action that would serve to identify the overall requirements for I/M in the State.

What Are Inspection and Maintenance Programs?

Beginning with 1968 model-year vehicles, automobiles manufactured in or imported into the U.S. have had to comply with emission standards specified in the Federal Motor Vehicle Emission Control Program (FMVECP). Under this program, maximum emission rates are established for new vehicles, and manufacturers must demonstrate through an auditing program that their vehicles are in compliance with these emission limits. The emission standards specified by the FMVECP require progressively more stringent control of emissions with each subsequent model year.

To comply with the emission standards, manufacturers have retained their existing engine design concepts, but developed emission control devices (crankcase ventilation control, catalytic converters, etc.) and revised certain system parameter specifications (air-to-fuel ratio, ignition timing, etc.). This approach to emission control ostensibly satisfied the requirements of the FMVECP for new vehicles. However, surevillance studies conducted by EPA disclosed that the emission rate for these "controlled" vehicles generally increased with time at a much greater rate than was expected, therefore reducing greatly the overall effectiveness of the FMVECP. Further analyses determined that the root causes of the rapid deterioration of these emission control systems could be traced to either improper or inadequate maintenance, or tampering with the devices or system settings.

In light of these findings, effort has been expended on developing techniques for reducing the air quality impact of poor maintenance practices and tampering. One result of this effort is the evolution of the inspection and maintenance concept.

In its most basic sense, inspection and maintenance refers to a program where vehicle exhaust emission levels are measured during specified operating conditions and compared with a specified standard for that particular vehicle configuration. If the measured rate exceeds the standard, the need for some form of maintenance, ajustment or repair is indicated. This is a very simplistic explanation of I/M, but it does serve to define the basic concept involved. A more precise discussion of various technical aspects of I/M may be found in the EPA report, entitled, "Summary Report on Vehicle Emissions Inspection and Maintenance Programs."

A variety of approaches have been used to run I/M programs, but the major types are generally in three organizational categories, as follows:

1. Government - Centralized test facilities operated by state, city, or local government (as in New Jersey; Cincinnati, Ohio; Portland, Oregon; and Chicago, Illinois).

2. Contractor - Centralized facilities operated by a private corporation under contract to a government (as in Maricopa and Pima Counties, Arizona).

3. Private Garage - Decentralized facilities operated by private automobile service garages, certified or licensed by government (as in Rhode Island and Nevada).

The major technical issues that need to be addressed in setting up an I/M program include:

1. Type of Emissions Test - Idle or Loaded

2. Geographical Coverage

3. Organizational Approach

4. Frequency of Inspection

5. Enforcement Procedure

6. Vehicles To Be Tested

7. Vehicles To Be Exempted

8. Data Handling Procedures

9. Adjunctive Programs (e.g., Public Information, Consumer Protection-Mechanic Training, etc.)

BACKGROUND OF THIS STUDY

Given the likelihood of I/M being required in the State of Wisconsin, a decision was made to establish an interagency technical committee comprised of staff members from the Departments of Natural Resources and Transportation, whose responsibility would be to develop the initial program framework and provide technical support for state policy makers.

The initial effort by the committee was to review the most current literature relevant to I/M, and investigate a number of specific technical issues that would eventually have to be addressed in the development of the I/M program. From this literature review, a total of 55 possible program scenarios were defined and evaluated. As a result, a final list of six specific program options, which appeared to be the options that were best suited for the State, was defined. The basic elements included in each of these options are delineated in Table 46. Upon reviewing Table 46, it is quite apparent that there are many similarities among the options. The primary differences relate to test type (idle or loaded mode), operation (contractor-run centralized facilities, state-operated centralized facilities, or private garage operation), and whether or not additional types of inspections (i.e., safety and noise) are integrated into the program.

A decision was made to limit the coverage of the I/M program to the nine counties listed below:

Brown County
Dane County
Kenosha County
Milwaukee County
Ozaukee County
Racine County
Walworth County
Washington County
Waukesha County

These counties represent the most highly urbanized areas within the state, and are, therefore, the most appropriate for implementing I/M. Owing to the rural nature of the remaining counties, there would likely not be a significant advantage to extending the program to statewide coverage at the present time.

A detailed, comparative analysis of the six options was performed that considered costs, benefits, and resource requirements.[1] With regard to costs, the analysis considered several categories including (1) capital costs,

TABLE 46. I/M OPTIONS ANALYZED

Option no.	Geographic coverage	Test mode	Operation and operating agency	Vehicles to be inspected	Remarks
1	Nine counties*	Loaded	Centralized facilities; contractor operated	All passenger cars and light trucks with GVW less than 8,500 pounds except those less than 1 or more than 12 years old	30 percent stringency factor; annual inspections; mechanic training to be performed; safety and noise inspections to be performed, also†
2	Nine counties*	Loaded	Centralized facilities; contractor operated	Same as Option 1	30 percent stringency factor; annual inspections; mechanic training to be performed
3	Nine counties*	Idle	Centralized facilities; contractor operated	Same as Option 1	Same as Option 2
4	Nine counties*	Loaded	Centralized facilities; state operated	Same as Option 1	Same as Option 1 (includes safety and noise inspections)†
5	Nine counties*	Idle	Centralized facilities; state operated	Same as Option 1	Same as Option 2
6	Nine counties*	Idle	Inspections performed in private service stations and garages	Same as Option 1	Same as Option 2

*Includes Brown, Dane, Kenosha, Milwaukee, Ozaukee, Racine, Walworth, Washington, and Waukesha Counties

†Safety and noise inspections would be statewide

initial start-up costs, (3) annual operating costs, and (4) annual administrative costs. These categories served as the basis for calculating the total annual cost of each option; this total annual cost was translated to an inspection fee that would be charged for each inspection by dividing it by the expected average annual number of paid inspections over the first several years of operation. The fees calculated for each are shown in Table 47 below.

TABLE 47. BREAKEVEN FEES IN CONSTANT 1978 DOLLARS FOR OPTIONS 1 THROUGH 6

Option	Key elements	Fee estimate*
1	Centralized, contractor-run, loaded-mode test, with safety and noise inspections	$7.24
2	Centralized, contractor-run, loaded-mode test	3.40
3	Centralized, contractor-run, idle-mode test	3.15
4	Centralized, state-run, loaded-mode test, with safety and noise inspections	6.87
5	Centralized, state-run, idle-mode test	3.13
6	Private garages and service stations performing idle-mode tests	3.00 - 6.00†

*Constant 1978 dollars, paid retest.

†Private garage fee is a function of the participation rate (i.e., the number of garages participating); the range shown in the table reflects a participation rate of about 35 to 75 percent.

Table 47 indicates that, in general, there will not be substantial differences in the costs of similar options (e.g., Options 1 and 4, 2 and 3, or 3 and 5). For example, a centralized network of idle-mode emission inspection stations would require a fee of $3.13 if the State assumes operational responsibility, while the fee would be $3.15 if a private contractor operates the network. A fairly substantial fee differential is indicated in comparing inspection options that include safety, noise, and emissions inspections, with options calling only for emissions inspections. This differential can be seen in comparing Options 1 and 2, where fees of $7.24 and $3.40 are indicated for centralized, contractor-run, loaded-mode emissions testing, with or without safety and noise inspections, respectively. Option 6 is somewhat different from the first five in that private garages or service stations will conduct emissions inspections. The estimated cost for an inspection under Option 6 is dependent on the number of garages that participate in the program. As the participation rate increases, each station's share of the inspections is reduced, thereby requiring a higher fee for each inspection in order to break even. As is indicated by Table 47, the range in the estimated fee is similar to the range in fee estimates for Options 1 through 5.

Benefits associated with each option were analyzed in detail. Two primary categories of benefits are identified with I/M programs, including (1) reductions in carbon monoxide and hydrocarbon emissions, and (2) improved fuel economy for those vehicles undergoing maintenance because of the program. With regard to quantifying these benefits, available data indicates that there are no differences in the level of emissions reduction or improvement in fuel economy achievable across the six options, assuming, of course, that the quality of both inspections and maintenance performed do not very from option to option. Using EPA's Mobile 1 computer routine, average daily carbon monoxide and reactive hydrocarbon emissions were computed for both 1977 and 1987.* Comparing the estimated 1987 emissions with a I/M program, to the 1987 emissions without an I/M program shows a decrease in total carbon monoxide emissions of approximately 29 percent, and a decrease in total reactive hydrocarbon emissions of 24 percent.

An estimate of the effect of an I/M program on fuel economy was also derived for the nine counties. Under the assumption used in each scenario (primarily with regard to the failure rate) it is estimated that by 1987, an annual fuel (gasoline) savings of 8.64 million gallons could be realized with an I/M program.

Other issues were raised, however, that indicated potential indirect benefits from the centralized lane approach as opposed to the decentralized garage options. Having a licensed private garage conduct both inspections and the necessary repairs for failed vehicles, raises potentially serious conflict of interest questions. Given the adverse publicity concerning alleged unethical repair practives in the repair industry, and given the technical difficulties in maintaning quality control on the several thousand emission analyzers across the state, this option was considered to have significant disadvantages in comparison to state or contractor centralized lanes. Quality control and supervision would be much better and uniformity of inspection results would consequently be far greater with centralized lanes.

Another issue that separates the options concerns the commitment of large numbers of state employees. In the state-run approach there would be a far greater number of new state employees, namely, the actual emissions inspectors. This employment issue was seen as potentially significant in view of the desirability of keeping the commitment of state manpower to a minimum. Moreover, the contractor approach allows for the option of state cancellation either during or at the end of the 5-year initial period, if the state wanted to take over the program itself.

Based in part on the information provided in the analysis of the six options, the Interagency Task Force selected one specific option that appears to best suit the needs of the State. This option is discussed in detail in the report and is highlighted here in the following pages. Discussed are costs, benefits, resource requirements, etc., associated with the program.

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*Two estimates for 1987 were developed; one with an I/M program in place and the other without any I/M.

OPTION DEFINITION

Essentially, the program selected involves establishing a network of centralized emissions inspection stations where loaded mode testing will be conducted. The basic loaded mode, centralized facility concept was selected for several reasons. First, it was considered that the loaded mode option offers several advantages over the idle mode, including more comprehensive diagnostic capabilities, and more flexibility in testing procedures. Also, there will likely be an NO_x standard defined in the near future for motor vehicles and NO_x testing may become necessary as part of the I/M program; NO_x testing can only be performed with the engines under a load, as when a loaded test is performed. The major disadvantage of the loaded mode test is that it is slightly more expensive to perform since additional test equipment is required. The incremental cost difference, however, is in the range of $0.20 to $0.25 per test and is not considered to be significant.

The primary reasons for selecting the centralized facility approach over private garages concerned program control and anticipated public acceptance of the program. Specifically, the State would be able to exercise much closer control over the inspection program with fewer personnel, which should result in a much higher quality program than would be achievable if the decentralized option was used. Further, it was considered that the public would be much less skeptical of a program where inspections were performed by an impartial entity who would not benefit from vehicles either failing or passing (primarily since repairs are not performed at the centralized facilities, nor are any individuals undergoing inspections considered "regular customers" who could bias the inspector).

One rather significant aspect of the program has not yet been determined - this concerns whether the State or a private contractor will be responsible for the construction and operation of test facilities. It is hoped that the results of the study being reported here will aid in arriving at a decision in this matter.

Other aspects of the option have also been defined. The geographic coverage will tentatively include only the nine counties considered previously, viz.,

- Brown County
- Dane County
- Kenosha County
- Milwaukee County
- Ozaukee County
- Racine County
- Walworth County
- Washington County
- Waukesha County

The inspection frequency has been defined as annual with inspections being staggered throughout the year.

The vehicle population to be tested consists essentially of all light-duty vehicles (LDV's) and light-duty trucks (LDT's) with a gross vehicle weight of 8,000 pounds or less. Some exemptions will be made, however, for vehicles such as farm trucks, research vehicles, and vehicles that are more than 15 years old.

The stringency level that will be used has been tentatively defined as 20 percent. Several supporting programs will also be established in conjunction with the I/M program, including: (1) public information, (2) consumer protection, (3) quality assurance, and (4) mechanic's training. These programs may be operated by the State or portions of each may be operated by contractors.

EMISSIONS INSPECTION SCENARIO

In order to illustate how the I/M program will work and where some of the ancillary programs tie in, the following description of the test procedure is offered.

The requirements for an emissions inspection in each instance will be related to the annual registration procedure; that is, emissions inspections will be required generally during the period when registration renewals are due. To initiate the registration renewal process, the Division of Motor Vehicles, within the Department of Transportation, will mail out registration renewal forms to motorists within the nine counties approximately prior to the registration renewal date. After receiving the material motorists will take their vehicles to contractor (or state) operated stations for inspection.

At the inspection station, the motorist will present his renewal forms, from which certain information will be collected and entered into a computer file. This information would relate to items such as:

- vehicle and registration identification data
- vehicle configuration (body style, engine type, etc.)
- test type (first test, or retest).

If the vehicle is exempt, the owner is given an official waiver form printed by the computer, and his registration form is stamped accordingly. He then either mails or brings the stamped registration renewal material to the Division of Motor Vehicles registration office where the registration transaction takes place.

Nonexempt vehicles proceed through the test lanes where the actual emission measurements are performed. Based on the vehicle data that are input at the beginning of the test, pass-fail criteria are automatically adjusted to the specific vehicle being tested. If the vehicle passes the test, the registration form is stamped appropriately and the motorist either mails or personnally takes the stamped form to a Division of Motor Vehicles office where the registration renewal is processed.

If the vehicle fails inspection, the computer prints out a form stating which standards are being exceeded, and by how much. The owner will be advised of the probable cause for failure, and required to have the vehicle repaired and inspected within a specified number of days. The owner will then take the vehicle (and the failure form) to a repair station where it is repaired at the owner's expense. The mechanic completes the repair form indicating the type of repair work performed.

The vehicle owner then takes the completed form and the vehicle back to a contractor (or state) test facility for a free retest. If it now meets emissions standards, the registration form is stamped and the owner completes the registration process as described above.

If the vehicle fails the first retest, the vehicle owner is obliged to go through the repair and reinspection cycle once again; however, if the accumulated total of repair costs exceeds the repair cost limits, he will be granted a waiver as before. The second retest (and those following if necessary), however, will cost the same amount as the original test.

Should the motorist at any point in the above process have a complaint concerning either the inspection or the maintenance phase, he may register the complaint with the Department of Transportation. Depending on the nature of the complaint, a variety of different actions may be taken. The motorist, for example, may be referred to a public relations official for more information about the program, or should any complaint uncover criminal actions, it would be referred to the Attorney General's Office for criminal proceedings.

I/M PROGRAM NETWORK

Vehicle Population Projections

An important part of this study was deriving a reasonable estimate of the number of vehicles that would actually be inspected during the period of 1982 through 1987. It was necessary to make accurate projections of the motor vehicle population for each county in order to derive the network of stations that would need to be constructed throughout the nine counties.

Using detailed county registration data provided by the Wisconsin Department of Transportation, it was possible to make inspectable vehicle population estimates using two different methods. The first method involved applying an annual growth rate of 3 percent to the current vehicle population. The second method was to derive separate growth rates for each individual county based on vehicle population trends within that county, and to apply these growth rates to the current population. The two resultant projections of inspectable vehicle populations are shown in Table 48.

Then, to arrive at the number of actual inspections per year, the vehicle populations shown in Table 48 were increased by 20 percent to account for retests of failed vehicles.

TABLE 48. 1987 INSPECTABLE VEHICLE POPULATION, USING TWO DIFFERENT PROJECTION METHODS

County	Method I	Method II
Brown	117,789	119,335
Dane	219,871	221,928
Kenosha	84,772	76,908
Milwaukee	638,456	523,051
Ozaukee	48,608	56,516
Racine	121,438	109,278
Walworth	50,530	46,831
Washington	56,528	66,073
Waukesha	202,836	235,399
Total	1,540,918	1,455,319

For purposes of cost analysis, it was useful to calculate the average number of inspections between 1982 and 1987. These projections, using Method II, are shown in Table 49.

TABLE 49. INSPECTIONS REQUIRED 1982 TO 1987

Year	Inspections required
1982	1,296,000
1983	1,327,000
1984	1,358,000
1985	1,389,000
1986	1,422,000
1987	1,455,000
Average	1,375,000

Network of Inspection Facilities

The annual capacity of a centralized emission inspection lane was calculated based on the vehicle throughput time, the number of inspection-hours per year, and an efficiency factor to account for random arrival of vehicles, equipment down time, etc. The centralized facilities are typically highly automated, multi-lane stations that utilize a 3-stop assembly line approach to maximize efficiency. These facilities are capable of a 2-minute throughput time. It was assumed that the facilities would be open 40 hours per week, 52 weeks per year, and operate at 67 percent efficiency. This translates to an annual capacity of 41,808 inspections per year. By dividing the numbers of inspections required in each county by the annual capacity of a single lane, the total numbers of lanes needed for each county were derived.

In locating the inspection facilities, the maximum facility size was limited to six lanes due to the problems associated with locating suitable large parcels. To maximize consumer convenience, facilities were located in or near the population centers of their respective counties. The defined inspection network is presented in Table 50.

PROGRAM ADMINISTRATION AND PERSONNEL REQUIREMENTS

The operational and administrative personnel requirements for both the state-run and contractor-run option were defined. Based on the experiences of programs currently in operation, the operational personnel were defined as shown in Table 51. These individuals would be involved in the inspection station operation.

Administrative personnel requirements were also defined. The particular administrative structure developed here reflects the minimum requirement; it is likely that additional personnel, particularly consumer protection and quality assurance investigators, may be required as the program progresses. The structure for state-run and contractor-run options are shown in Figures 11 and 12, respectively.

Total numbers of persons employed by the program are shown in Table 51 for both a state-run and a contractor-run option.

I/M PROGRAM BENEFITS

Concern for controlling automative emissions stems from the fact automobile traffic is responsible for approximately 75 percent of all urban carbon monoxide (CO) emissions, 50 percent of hydrocarbon (HC) emissions, and 50 percent of oxides of nitrogen (NO_x) emissions. U.S. EPA data suggest that automobile transportation is responsible for as much as 1/4 to 23 percent of total air pollution costs. A 1978 study by the National Highway Traffic Safety

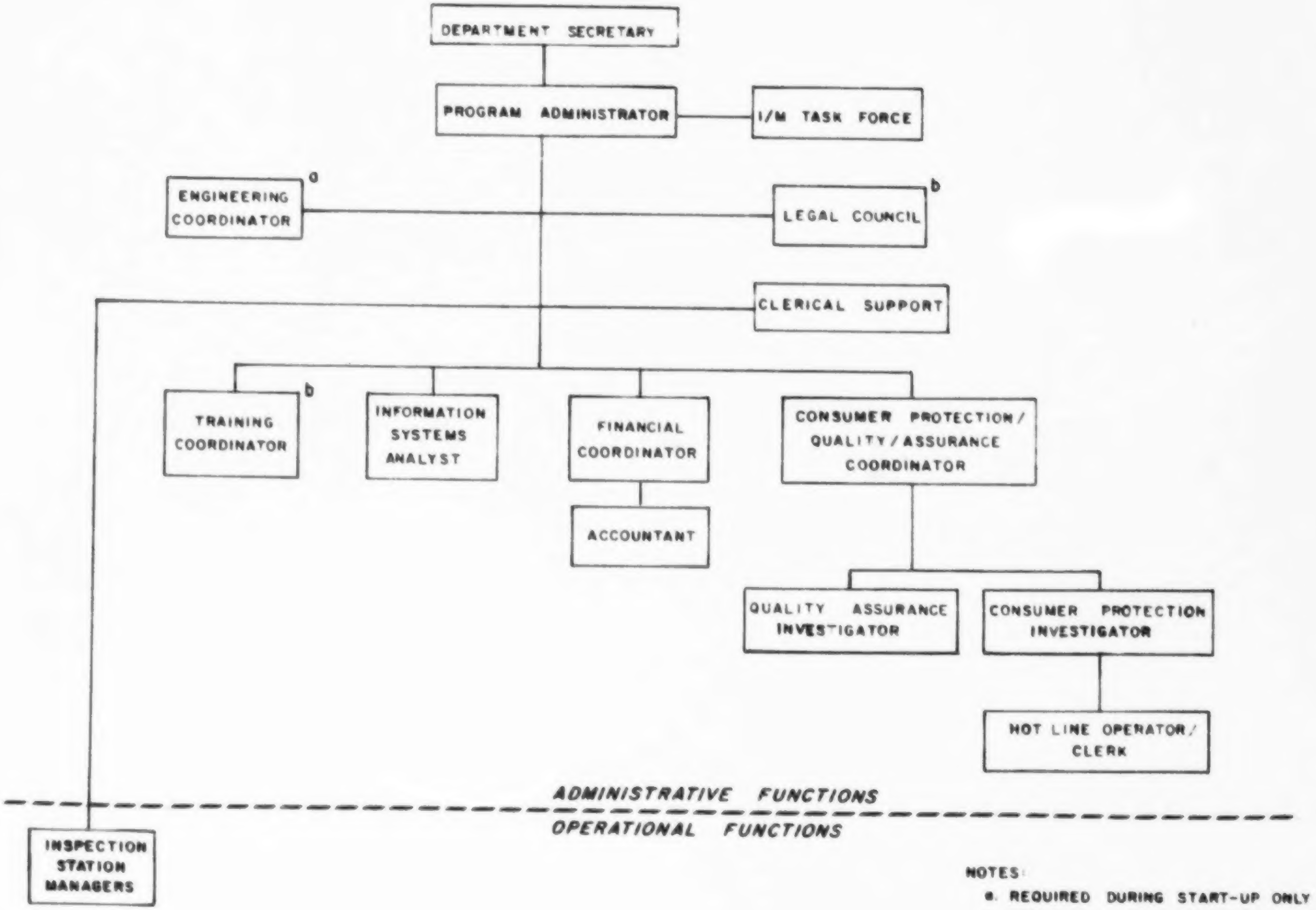
TABLE 50. INSPECTION NETWORK

County	Facility	Location
Brown	4-lane	Green Bay
Dane	4-lane 3-lane	Madison Madison
Kenosha	3-lane	Kenosha
Milwaukee	6-lane 6-lane 3-lane	Milwaukee Milwaukee Greenfield
Ozaukee	2-lane	Meguon
Racine	4-lane	Racine
Walworth	2-lane	Elkhorn
Washington	2-lane	West Bend
Waukesha	4-lane 3-lane	Brookfield Waukesha
Total	46 lanes, 13 facilities	

Total numbers of persons employed by the program are shown in Table 51 for both a state-run and contractor-run option.

TABLE 51. PROGRAM EMPLOYEES

Personnal affiliation	Number of employees	
	State-run	Contractor-run
Contractor (Administrative)	0	5
Contractor (Operating)	0	169
State (Administrative)	12	9
State (Operating)	169	0
Total	181	183


DEPARTMENT SECRETARY
PROGRAM ADMINISTRATOR
I/M TASK FORCE
ENGINEERING COORDINATOR
a
LEGAL COUNCIL
b
CLERICAL SUPPORT
TRAINING COORDINATOR
b
INFORMATION SYSTEMS ANALYST
FINANCIAL COORDINATOR
ACCOUNTANT
CONSUMER PROTECTION/ QUALITY/ASSURANCE COORDINATOR
QUALITY ASSURANCE INVESTIGATOR
CONSUMER PROTECTION INVESTIGATOR
HOT LINE OPERATOR/ CLERK
ADMINISTRATIVE FUNCTIONS
OPERATIONAL FUNCTIONS
INSPECTION STATION MANAGERS

NOTES:
a. REQUIRED DURING START-UP ONLY
b. NOT A FULL-TIME POSITION

Figure 11. Suggested administrative structure for the state-run option.

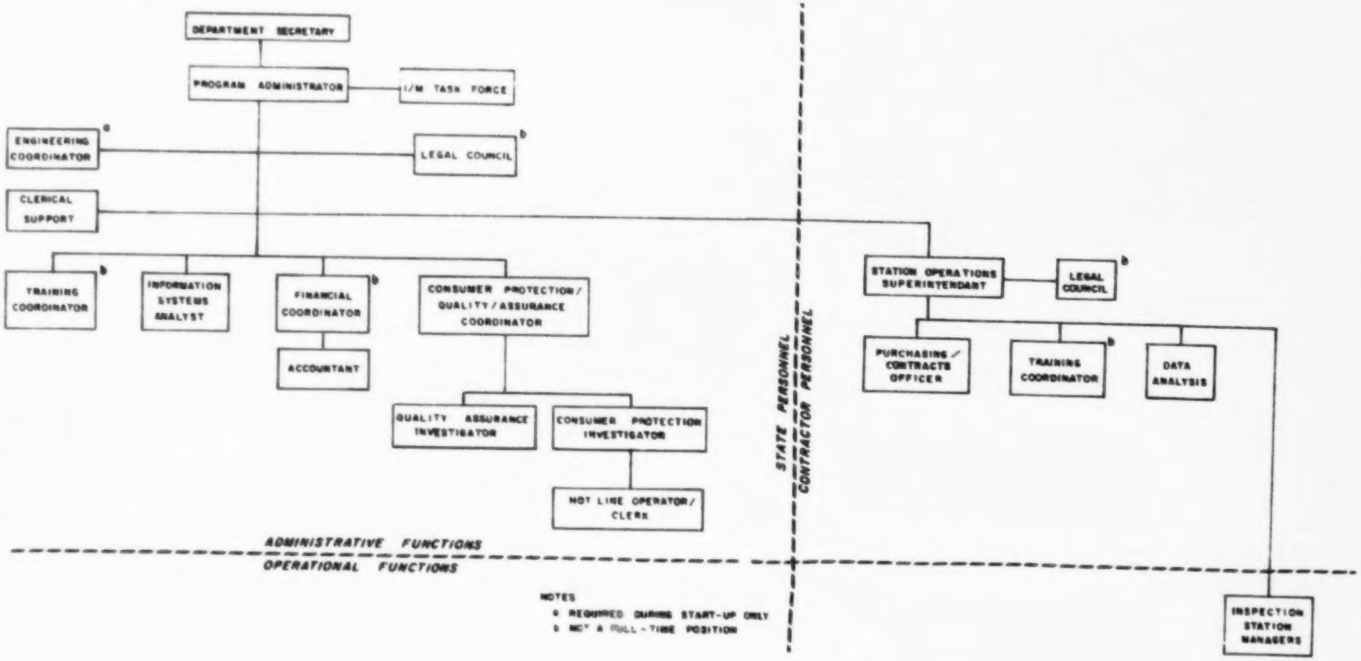

DEPARTMENT SECRETARY
PROGRAM ADMINISTRATOR
I/M TASK FORCE
ENGINEERING COORDINATOR a
LEGAL COUNCIL b
CLERICAL SUPPORT
TRAINING COORDINATOR b
INFORMATION SYSTEMS ANALYST
FINANCIAL COORDINATOR b
ACCOUNTANT
CONSUMER PROTECTION/ QUALITY/ASSURANCE COORDINATOR
QUALITY ASSURANCE INVESTIGATOR
CONSUMER PROTECTION INVESTIGATOR
HOT LINE OPERATOR/ CLERK
STATE PERSONNEL
CONTRACTOR PERSONNEL
STATION OPERATIONS SUPERINTENDANT
LEGAL COUNCIL b
PURCHASING/ CONTRACTS OFFICER
TRAINING COORDINATOR b
DATA ANALYSIS
ADMINISTRATIVE FUNCTIONS
OPERATIONAL FUNCTIONS
INSPECTION STATION MANAGERS
NOTES
a REQUIRED DURING START-UP ONLY
b NOT A FULL-TIME POSITION

Figure 9. Suggested administrative structure for the contractor-run option.

Administration indicates that "the prorated societal cost of air pollution caused by automobiles would be equivalent to from $24.30 to $64.30 per vehicle."[2] This same study states that "it is conceivable that national inspection and mandatory maintenance would reduce societal cost of pollution $1.3 to $3.4 billion annually."

Besides these economic benefits and the benefit of decreased emissions seen from I/M implementation, other important benefits may accrue. These include an improvement of fuel economy, which in turn has a positive effect on gasoline consumption. Benefits have also been indicated for fleets that undergo their own special maintenance programs.

Emissions Reductions

Emissions reduction is the primary benefit to be derived from I/M programs. Although new vehicles are required to meet certain EPA specifications for emissions, it has been shown that emission rates for in-use vehicles deteriorate significantly unless adequate maintenance is performed. I/M has been suggested as an effective means for ensuring that the necessary maintenance be performed periodically, thus resulting in a significant decrease in emissions generated by the motor vehicle population.

The emission reductions ("tail-pipe" reductions) refer to the decrease in carbon monoxide (CO) and hydrocarbons (HC) from the I/M vehicles. The resultant change in the concentrations of CO and HC in the ambient atmosphere is not being considered here.

Various levels of reductions in emissions have been noted in ongoing I/M programs. Actual reductions vary with the stringency factor, climate, etc. Hamilton Test Systems, under contract to the State of Arizona, noted in a 1978 report[3] that of those vehicles undergoing inspection and subsequent maintenance, 25 percent reduction in idle CO emissions, and 41 percent reduction in idle HC emissions were shown compared to those tested in 1976 (pre-I/M). Hamilton Test Systems claims that the program is reducing by about 250 tons daily the amount of CO and HC emitted into the atmosphere in the Arizona counties covered by I/M, as well as saving motorists an estimated 30 million gallons of gasoline annually.[4]

Analyses performed by other states and federal agencies[5] show similar results.

Projected Reduction in Emissions

In order to estimate the magnitude of the reduction in emissions that results over time from the implementation of an I/M program in Wisconsin, motor vehicle emission inventories for both CO and HC were developed using EPA's MOBILE I computer routine. Input data regarding vehicle-miles of travel (VMT) by vehicle type, roadway functional class, and speed were provided by the Wisconsin Department of Transportation.

Inventories were prepared for each year beginning with 1983 through 1987 for each of the nine counties. Average daily emissions generated by light-duty vehicles (cars and trucks) and by all vehicles were defined for two scenarios. The first scenario reflected the vehicle population emission characteristics in the absence of an I/M program, while the second scenario reflected the compounded effects of an I/M program beginning (mandatory maintenance) in January 1982 on emissions each year. The percent reduction in carbon monoxide and hydrocarbon emissions attributable to the I/M program from 1982 to 1987 is shown in Table 52 and Figures 13 and 14.

TABLE 52. PROJECTED PERCENT REDUCTIONS IN CO AND HC EMISSIONS 1983 TO 1987 DUE TO I/M*

	1983	1984	1985	1986	1987
Light-duty cars and trucks					
CO	19	28	36	43	50
HC	14	20	27	35	42
All vehicles					
CO	14	20	25	29	35
HC	12	17	23	30	36

*Stringency rate = 20 percent.

The effects on emission reductions of increasing the stringency (failure rate) to 30 and 40 percent were also studied. Increasing the stringency level above 20 percent results in only very slight additional reductions in HC or CO. The reason for this is that at 20 percent failure, nearly all of the gross pollution emitters are failed, whereas the additional cars that fail when the standards are set above this level only marginally exceed the standards. Repairing these vehicles, then, has only a marginal effect on emission reductions because the worst polluters were already identified and repaired at the 20 percent level.

The reductions shown in Table 52 occur with a stringency level of 20 percent, which means that test standards are set such that 20 percent of the total vehicles tested will fail and require repairs. U.S. EPA requires that the program produce at least a 25 percent reduction in emissions in 1987 from vehicles included in the program (which are basically the light-duty vehicles or passenger cars, and the light-duty trucks, or all trucks under 8,500 lbs GVW) in comparison to the emissions that would be produced by these same vehicles in 1987 without the program. The figures shown above indicate that the proposed I/M program will, on the average for all counties, achieve a

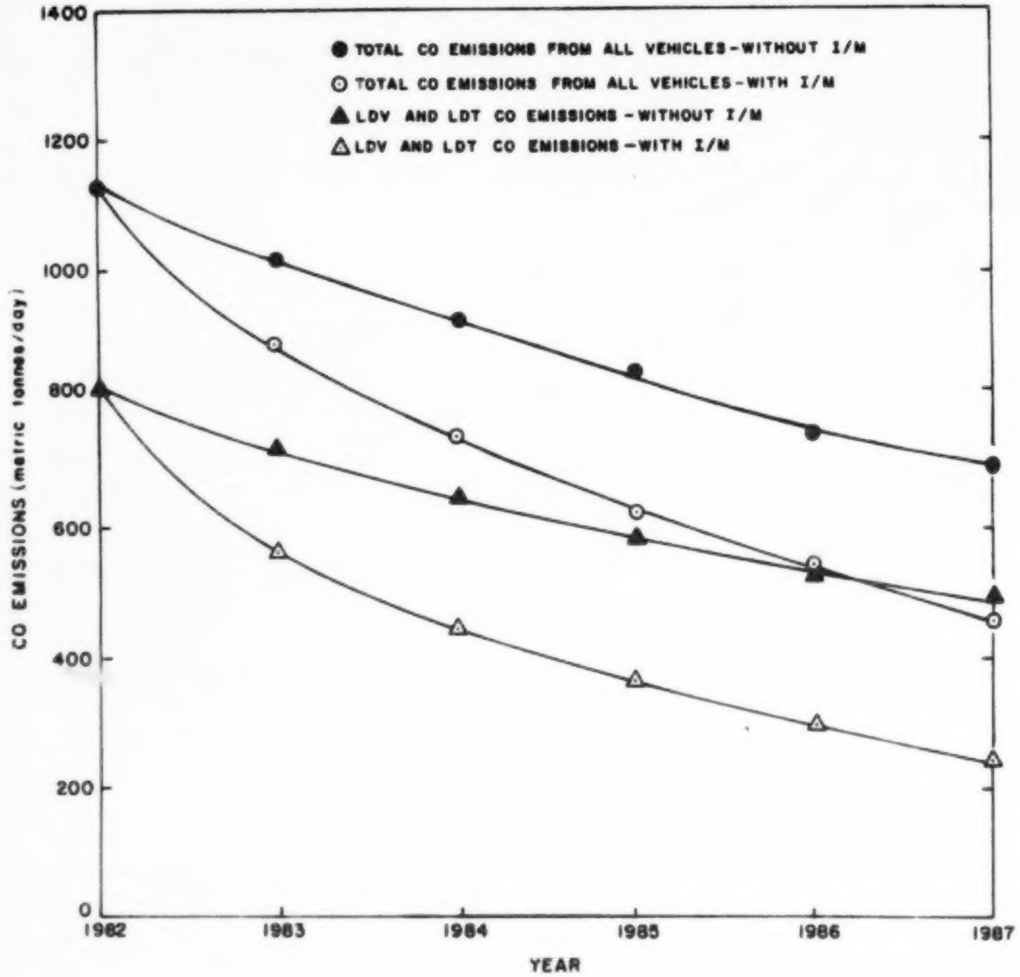


Figure 13. Daily CO emissions by year for LDV's and LDT's, and all vehicles with and without I/M - 1982 through 1987.

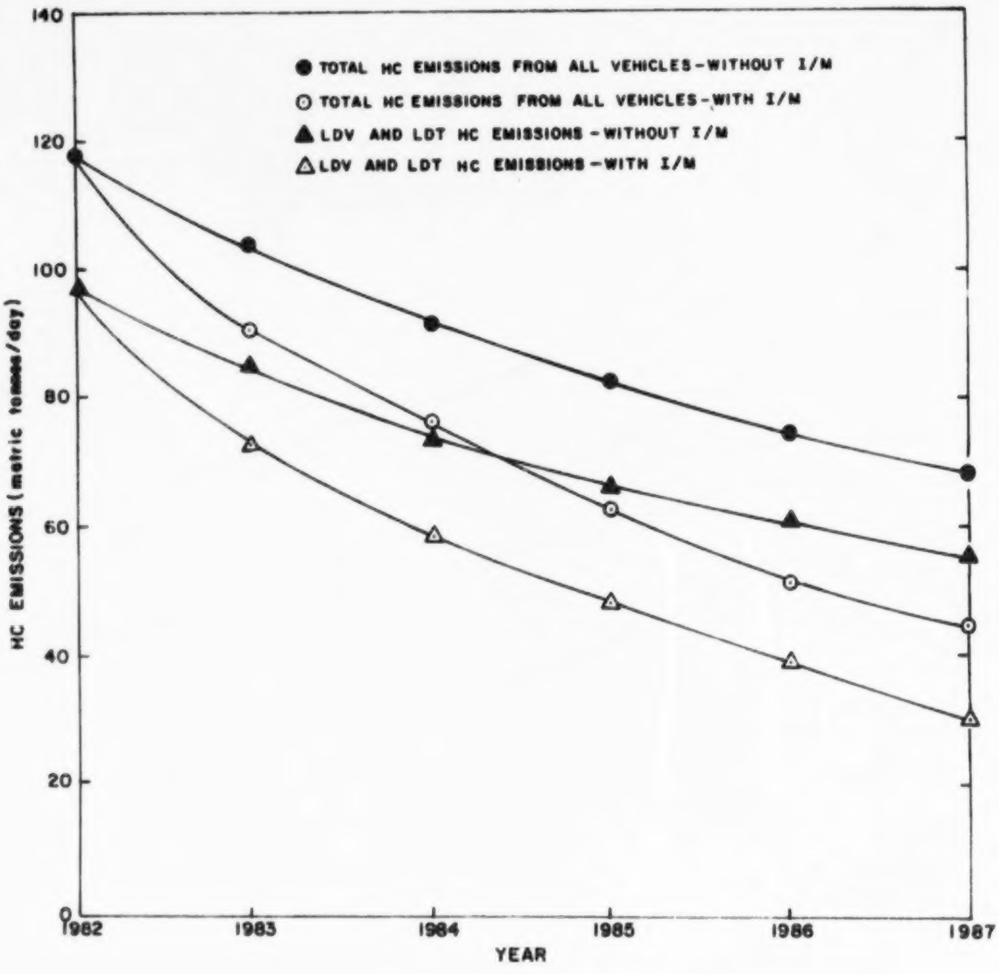


Figure 14. Daily HC emissions by year for LDV's and LDT's, and all vehicles, with and without I/M - 1982 through 1987.

reduction of 50 percent and 42 percent for CO and HC, respectively, indicating that program stringency is more than adequate to meet EPA's minimum standards. Reductions by year are shown graphically for CO and HC in Figures 10 and 11, respectively.

Fuel Economy Benefits

One of the important benefits of I/M programs, in addition to the reduction in vehicular emissions, is potential fuel conservation. A properly tuned engine operates with greater efficiency and therefore, consumes less fuel. This improvement in fuel economy varies somewhat from one program to another but most sources agree that a 5 to 10 percent fuel economy improvement for the failed and maintained vehicles can be expected. This may understate the overall fleet improvement as some motor vehicle owners are likely to schedule tune-ups just prior to having their cars inspected. One of the purposes of I/M is to give an incentive to motorists to maintain their cars better than they normally would in the absence of I/M.

For the purposes of this study, it is assumed that the fuel economy improvement for vehicles that fail the emissions test and therefore undergo maintenance, will be 7 percent averaged over a year. Applying this to the projected vehicle population in the nine counties in 1987, the failure rate chosen - 20 percent, and the relative travel distribution by various model year vehicles, it is estimated that during 1987, approximately 5.76 million gallons of gasoline would be saved as a result of the I/M program. Assuming further that the cost of gasoline in 1987 will be $0.80 per gallon, the fuel cost savings associated with the 5.76 million gallons of fuel conserved is $4.6 million. A detailed discussion concerning the derivation of the fuel savings associated with the program is presented in Section 3, Benefits, and Appendix C of the report.

Impact on Vehicle Performance and Life

The effects of inspection and maintenance programs on vehicle performance and life are currently under study. Preliminary analyses in this area have focused on various vehicle fleets and indicate that I/M does have a positive effect on both vehicle performance and vehicle life, although specific, quantitative statistics are not yet available.

Some of the more notable findings to date regarding vehicle performance come from programs established for fleets of vehicles by their owners. One such program may be found in the City of Phoenix, Arizona. In order to reduce on-the-road failures, an extensive preventive maintenance inspection program was implemented for the city's vehicle fleet. Results of the program were closely monitored resulting in the determination that: (1) the fuel consumption rate during the first 6 months of the program decreased approximately 10 percent, much of which was attributable directly to the program; and (2) a significant decrease occurred in the number of vehicles breaking down on the road and requiring towing.

I/M PROGRAM COSTS

Program Costs

The development of the specific costs presented in this section relies on an analysis and breakdown of the program elements into specific cost components. These cost components are based on the actual experiences of other states that have implemented I/M programs very similar to the contractor-operated centralized network described in this report. Arizona has an I/M program similar in many ways to the one analyzed here. In addition, a thorough analysis of the program functions and elements was undertaken to ensure that the costs reflect as closely as possible the probable costs that will be experienced when Wisconsin implements the proposed I/M program. However, it must be realized that while conservative cost assumptions were made whenever feasible, that there may be considerable variation in the individual cost elements due to fluctuations in markets and in the economy.

Table 53 presents an outline of the various costs, broken down into their component parts. Next, cost summaries for a state-run and a contractor-run option are provided in Tables 54 and 55, respectively.

Inspection Fee Estimate

An estimate of the minimum inspection fee (breakeven fee) was calculated in both constant 1978 dollars and actual (inflated) dollars for the period from 1982 through 1987, for both the state-run and contractor-run options. These fees were calculated by dividing the total annualized costs by the average number of registrations in this period (a free retest was assumed). For the fee in actual (inflated) dollars, a 7 percent inflation rate was assumed. The fees are shown in Table 56.

TABLE 56. BREAKEVEN FEES, f_c, IN REAL 1978 DOLLARS, AND f_a, IN ACTUAL DOLLARS FOR THE STATE-RUN AND CONTRACTOR-RUN OPTIONS

Option	Fee in real (1978) dollars	Fee in actual dollars
State-run	4.33	5.45
Contractor-run	4.54	5.71

ADJUNCTIVE PROGRAMS

Several basic support programs were investigated in this study. All of these programs are important in terms of enhancing the overall effectiveness of the program, keeping the public informed, and protecting the consumer from potential abuses or inequities in the system. In brief the programs are as follows:

TABLE 53. OUTLINE OF PROGRAM COST CATEGORIES AND ELEMENTS

Primary category	Principal element	Items included
I. Initial Capital Costs	1. Building investment	a. Construction cost
	2. Land investment	a. Actual land cost b. Pavement amd ;amdscaping
	3. Equipment costs	a. Primary test equipment b. Ancillary equipment c. Office equipment/furniture d. Maintenance equipment
II. One-Time Startup Costs	1. Land acquisition	a. Site location studies b. Title transfer costs
	2. Facilities planning	a. Design study b. Bid efaluation c. Construction monitoring
	3. Program design	a. Develop equipment specifications b. Develop subprograms (e.g., public information, surveillance, quality control, enforcement, etc.) c. Define personnel organizational structure d. Define personnel organizational structure e. Plan program effectiveness studies
	4. Develop data handling systems software	
	5. Personnel training	a. Inspectors b. Managers c. Quality control personnel d. Mechanics training
	6. Personnel salaries and overhead prior to startup	
	7. Initial public information program	
	8. Mechanics training program	
III. Annual Operating Costs	1. Facility personnel	a. Wages, benefits, etc.
	2. Maintenance	a. Equipment
	3. Utilities/services/supplies	a. Electric b. Heat c. Insurance d. Miscellaneous e. Taxes
IV. Annual Administrative Costs	1. Program administrative personnel	a. Wages, overhead
	2. Enforcement	
	3. Consumer protection quality assurance	
	4. Public information	
	5. Training, licensing, certification	

TABLE 54. COST SUMMARY - STATE-RUN OPTION

	Primary category		Principal element	Element cost ($)	Total category cost ($)
I.	Initial Capital Costs	1.	Building investment	5,323,375	
		2.	Land investment	2,049,376	
		3.	Equipment costs	3,674,300	
					11,047,051
II.	One-Time Start-up Costs	1.	Land acquisition	245,170	
		2.	Facilities planning	1,064,675	
		3.	Program design	100,000	
		4.	Software development	200,000	
		5.	Personnel training	3,784	
		6.	Personnel salaries and overhead	658,862	
		7.	Public information	204,000	
		8.	Mechanics training	36,380	
					2,512,871
III.	Annual Operating Costs	1.	Personnel	2,413,375	
		2.	Maintenance	635,800	
		3.	Utilities/services/supplies	572,938	
					3,622,113
IV.	Annual Administrative Costs	1.	Personnel	180,000	
		2.	Vehicle operation	3,600	
		3.	Public information	204,000	
		4.	Personnel training	272	
					387,872

TABLE 55. COST SUMMARY - CONTRACTOR-RUN OPTION

Primary category	Principal element	Element cost ($)	Total category cost ($)
I. Initial Capital Costs	1. Building Investment	5,323,375	
	2. Land investment	2,049,376	
	3. Equipment costs	3,674,300	
			11,047,051
II. One-Time Start-up	1. Land acquisition	245,170	
	2. Facilities planning	798,506	
	3. Program design	100,000	
	4. Software department	200,000	
	5. Personnel training	3,784	
	6. Personnel salaries and overhead	603,446	
	7. Public information	204,000	
	8. Mechanics training	36,380	
			2,191,286
III. Annual Operating Costs	1. Personnel	2,413,375	
	2. Maintenance	635,800	
	3. Utilities/services/supplies	922,549	
			3,971,724
IV. Annual Administrative Costs	1. Personnel	208,125	
	2. Vehicle operation	3,600	
	3. Public information	204,000	
	4. Personnel training	272	
			415,997

- quality assurance increases the quality and uniformity of the emission inspection and repair process
- mechanic training increases the quality of the emission repairs
- consumer protection protects the consumer from unneeded repairs or inequities in the testing
- public convenience minimizes travel time and waiting at the inspection lanes
- enforcement ensures a maximally effective system to ensure compliance
- public relations provides comprehensive information to the public on the needs, benefits, and procedures of the I/M program

It is important to realize that these adjunctive programs interrelate and overlap to a high degree. Some of the adjunctive program elements may serve multiple purposes. For example, mechanics training serves to increase the quality control of the repair or maintenance phase of the program, serves as an important consumer protection element by encouraging more uniform, less expensive emission tuneups and also may serve as a public relations mechanism by orienting the mechanics to the purpose and benefits of the overall I/M program.

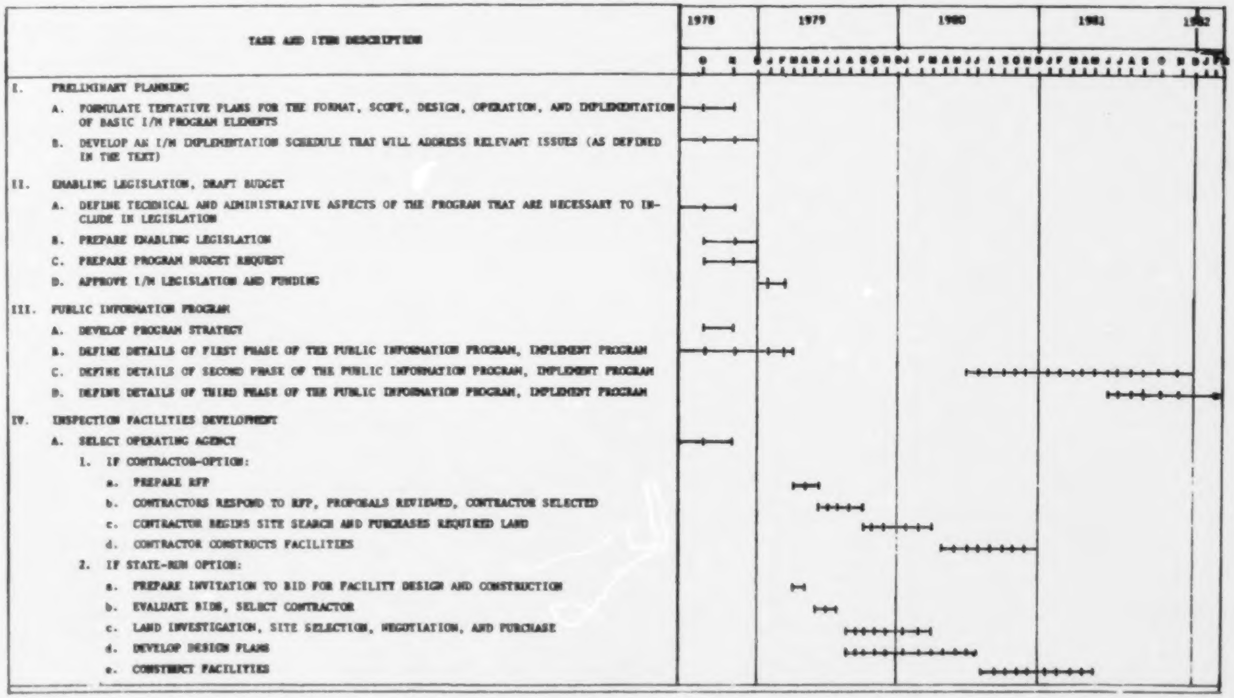
Program Implementation

Implementation of Wisconsin's I/M program will proceed according to the schedule shown in Table 57. This schedule has been specifically designed to meet all applicable Federal requirements while at the same time displaying differences between startup requirements applicable to the state-run and contractor-run options. For example, from Table 57 it can be seen that under the contractor-run option, a longer mandatory inspection-voluntary maintenance "trial period" would be possible than under a state-run option.

CONCLUSIONS

The basic observation is that there are no significant differences involved when comparing State-run and contractor-run options. From a more or less subjective viewpoint, however, there may be advantages to having a contractor finance, set-up, and run the program, simply because it frees the State from the direct responsibility of doing so, as well as eliminates the need for the State to invest large sums of money in the program. It also appears that there may be other types of advantages primarily with regard to how the public views the program. It has been indicated that the public may be somewhat more receptive to a program run by a private organization compared with State-run; these types of claims, however, are difficult if not impossible to substantiate. In conclusion, it would appear that the primary considerations in selecting the operating agency would likely be convenience and the impact on public perception rather than any technical aspect of either option.

TABLE 57. IMPLEMENTATION SCHEDULE - SUMMARY



TASK AND ITEM DESCRIPTION

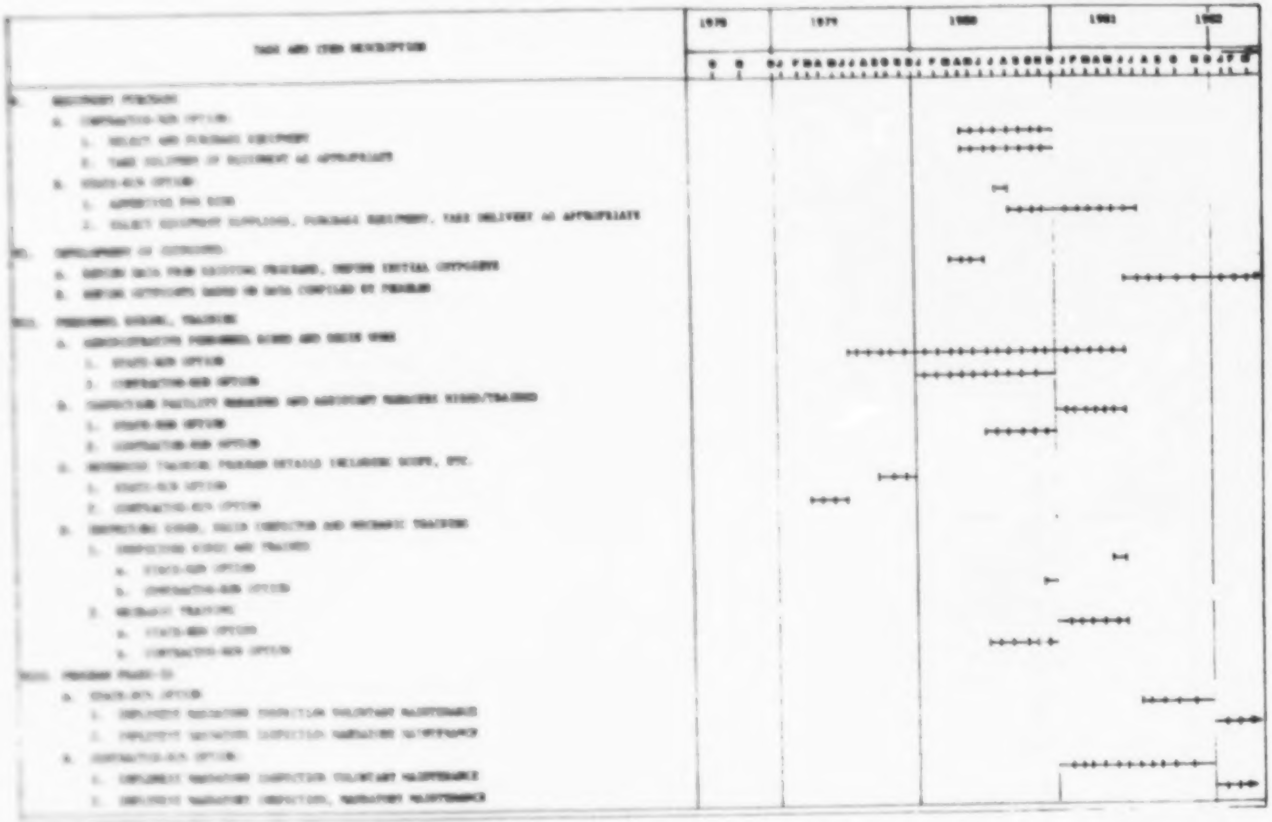
I. PRELIMINARY PLANNING
  A. FORMULATE TENTATIVE PLANS FOR THE FORMAT, SCOPE, DESIGN, OPERATION, AND IMPLEMENTATION OF BASIC I/M PROGRAM ELEMENTS
  B. DEVELOP AN I/M IMPLEMENTATION SCHEDULE THAT WILL ADDRESS RELEVANT ISSUES (AS DEFINED IN THE TEXT)

II. ENABLING LEGISLATION, DRAFT BUDGET
  A. DEFINE TECHNICAL AND ADMINISTRATIVE ASPECTS OF THE PROGRAM THAT ARE NECESSARY TO INCLUDE IN LEGISLATION
  B. PREPARE ENABLING LEGISLATION
  C. PREPARE PROGRAM BUDGET REQUEST
  D. APPROVE I/M LEGISLATION AND FUNDING

III. PUBLIC INFORMATION PROGRAM
  A. DEVELOP PROGRAM STRATEGY
  B. DEFINE DETAILS OF FIRST PHASE OF THE PUBLIC INFORMATION PROGRAM, IMPLEMENT PROGRAM
  C. DEFINE DETAILS OF SECOND PHASE OF THE PUBLIC INFORMATION PROGRAM, IMPLEMENT PROGRAM
  D. DEFINE DETAILS OF THIRD PHASE OF THE PUBLIC INFORMATION PROGRAM, IMPLEMENT PROGRAM

IV. INSPECTION FACILITIES DEVELOPMENT
  A. SELECT OPERATING AGENCY
    1. IF CONTRACTOR-OPTION:
      a. PREPARE RFP
      b. CONTRACTORS RESPOND TO RFP, PROPOSALS REVIEWED, CONTRACTOR SELECTED
      c. CONTRACTOR BEGINS SITE SEARCH AND PURCHASES REQUIRED LAND
      d. CONTRACTOR CONSTRUCTS FACILITIES
    2. IF STATE-RUN OPTION:
      a. PREPARE INVITATION TO BID FOR FACILITY DESIGN AND CONSTRUCTION
      b. EVALUATE BIDS, SELECT CONTRACTOR
      c. LAND INVESTIGATION, SITE SELECTION, NEGOTIATION, AND PURCHASE
      d. DEVELOP DESIGN PLANS
      e. CONSTRUCT FACILITIES

TABLE 57 (continued)



TASK AND ITEM DESCRIPTION

X. EQUIPMENT PURCHASE
  A. CONTRACTOR-RUN OPTION
    1. SELECT AND PURCHASE EQUIPMENT
    2. TAKE DELIVERY OF EQUIPMENT AS APPROPRIATE
  B. STATE-RUN OPTION
    1. ADVERTISE FOR BIDS
    2. SELECT EQUIPMENT SUPPLIERS, PURCHASE EQUIPMENT, TAKE DELIVERY AS APPROPRIATE

XI. DEVELOPMENT OF CUTPOINTS
  A. OBTAIN DATA FROM EXISTING PROGRAMS, DEFINE INITIAL CUTPOINTS
  B. REFINE CUTPOINTS BASED ON DATA COMPILED BY PROGRAM

XII. PERSONNEL HIRING, TRAINING
  A. ADMINISTRATIVE PERSONNEL HIRED AND BEGIN WORK
    1. STATE-RUN OPTION
    2. CONTRACTOR-RUN OPTION
  B. INSPECTION FACILITY MANAGERS AND ASSISTANT MANAGERS HIRED/TRAINED
    1. STATE-RUN OPTION
    2. CONTRACTOR-RUN OPTION
  C. DETERMINE TRAINING PROGRAM DETAILS INCLUDING SCOPE, ETC.
    1. STATE-RUN OPTION
    2. CONTRACTOR-RUN OPTION
  D. INSPECTORS HIRED, BEGIN INSPECTOR AND MECHANIC TRAINING
    1. INSPECTORS HIRED AND TRAINED
      a. STATE-RUN OPTION
      b. CONTRACTOR-RUN OPTION
    2. MECHANIC TRAINING
      a. STATE-RUN OPTION
      b. CONTRACTOR-RUN OPTION

XIII. PROGRAM PHASE-IN
  A. STATE-RUN OPTION
    1. IMPLEMENT MANDATORY INSPECTION VOLUNTARY MAINTENANCE
    2. IMPLEMENT MANDATORY INSPECTION MANDATORY MAINTENANCE
  B. CONTRACTOR-RUN OPTION
    1. IMPLEMENT MANDATORY INSPECTION VOLUNTARY MAINTENANCE
    2. IMPLEMENT MANDATORY INSPECTION, MANDATORY MAINTENANCE

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APPENDIX A

SENSITIVITY ANALYSES

GENERAL METHODOLOGY

Sensitivity analyses were performed on: (1) the affect of eliminating two counties, Brown and Dane, on the costs associated with the Inspection/Maintenance Program; (2) the affect of varying the stringency factor above and below 20 percent; and (3) the affect of reducing the age exemption from 15 years old to 10 years old.

OPTION COSTS

The technique used in developing the cost analysis for the seven county program was to utilize the same methodology and assumptions as appeared in Section 7 of the main report. All costs reported in this Appendix, unless otherwise noted, are in constant 1978 dollars. Costs are provided for both a state-run and a contractor-run program, where different.

Initial Capital Costs

These items are separated into three categories: building investments, land investments, and equipment costs.

Building Investments--

The cost for each facility in the seven county network, shown in Table A-1, is computed as the product of: (1) the building area, and (2) the unit cost $\$25/ft^2$. The building areas, as a function of facility configuration have been previously presented in Section 7; the total cost for construction, by county, is shown in Table A-2.

Land Investments--

Specific lot size requirements and unit costs for land, paving, and landscaping were derived in Section 7. Total land investments, including improvements, are presented in Table A-3.

Equipment Costs--

Equipment requirements and costs as a function of facility configuration were derived in Section 7. Total equipment costs by county are presented in Table A-4.

The capital costs anticipated for both the state and contractor operated systems are identical, and are summarized in Table A-5.

TABLE A-1. INSPECTION NETWORK REQUIREMENTS

County	Municipality	Number of facilities	Configuration (lanes)
Kenosha	Kenosha	1	3
Milwaukee	Milwaukee	2	6
	Greenfield	1	3
Ozaukee	Meguon	1	2
Racine	Racine	1	4
Walworth	Elkhorn	1	2
Washington	West Bend	1	2
Waukesha	Brookfield	1	4
	Waukesha	1	3
Total network		10 facilities	35 lanes

TABLE A-2. BUILDING COST ESTIMATES, SEVEN COUNTY OPTION

County	Facility configuration	Per facility cost, $	Number of facilities required	Total cost, $
Kenosha	3-lane	344,625	1	344,625
Milwaukee	6-lane	699,875	2	1,399,750
	3-lane	344,625	1	344,625
Ozaukee	2-lane	241,875	1	241,875
Racine	4-lane	454,875	1	454,875
Walworth	2-lane	241,875	1	241,875
Washington	2-lane	241,875	1	241,875
Waukesha	4-lane	454,875	1	454,875
	3-lane	344,625	1	344,625
Total				4,069,000

TABLE A-3. ESTIMATED LAND INVESTMENT REQUIREMENTS BY COUNTY, SEVEN COUNTY OPTION

County	Municipality	Facilities required	Configuration	Lot size per facility (ft²)	Land cost per ft² ($)	Cost per facility ($)	Total cost all facilities ($)	Total queue areas (ft²)	Total parking areas all facilities (ft²)	Total paved areas all facilities (ft²)	Paving cost per ft² ($)	Total paving cost ($)	Total landscaped area, all facilities (ft²)	Landscaping cost per ft² ($)	Total landscaping cost ($)	Total improvements all facilities ($)	Total land investment all facilities ($)
[illegible]	[illegible]	1	3-lane	68,925	1.70	117,173	117,173	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	141,807
[illegible]	[illegible]	2	6-lane	139,975	1.50	209,963	419,926	60,000	17,550	77,550	0.80	62,040	146,424	0.25	36,606	98,646	518,572
	[illegible]	1	3-lane	68,925	1.50	103,388	103,388	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	128,022
[illegible]	[illegible]	1	2-lane	48,375	0.60	29,025	29,025	10,000	3,105	13,105	0.80	10,484	25,595	0.25	6,399	16,883	45,908
[illegible]	[illegible]	1	4-lane	90,975	0.75	68,231	68,231	20,000	5,940	25,940	0.80	20,752	46,840	0.25	11,710	32,462	100,693
[illegible]	[illegible]	1	2-lane	48,375	0.67	32,411	32,411	10,000	3,105	13,105	0.80	10,484	25,595	0.25	6,399	16,883	49,294
[illegible]	[illegible]	1	2-lane	48,375	0.85	41,119	41,119	10,000	3,105	13,105	0.80	10,484	25,595	0.25	6,399	16,883	58,002
[illegible]	[illegible]	1	4-lane	90,975	2.50	227,438	227,438	20,000	5,940	25,940	0.80	20,752	46,840	0.25	11,710	32,462	259,900
	[illegible]	1	3-lane	68,925	2.30	158,528	158,528	15,000	4,725	19,725	0.80	15,780	35,415	0.25	8,854	24,634	183,162
							1,197,239					182,336			105,785	288,121	1,485,360

TABLE A-4. EQUIPMENT COSTS FOR LOADED MODE TESTING, SEVEN COUNTY OPTION

County	Municipality	Facility configuration	Number of facilities	Equipment cost per facility, ($)	Total cost of equipment, ($)
Kenosha	Kenosha	3-lane	1	219,500	219,500
Milwaukee	Milwaukee	6-lane	2	359,000	718,000
	Greenfield	3-lane	1	219,500	219,500
Ozaukee	Meguon	2-lane	1	173,000	173,000
Racine	Racine	4-lane	1	266,000	266,000
Walworth	Elkhorn	2-lane	1	173,000	173,000
Washington	West Bend	2-lane	1	173,000	173,000
Waukesha	Brookfield	4-lane	1	266,000	266,000
	Waukesha	3-lane	1	219,500	219,500
Total network					2,427,500
Calibration Vans and Equipment (4 at 33,000 each)					132,000
Central Computer					250,000
Security Systems					14,300
Quality Assurance Investigator's van and equipment					33,000
Consumer Protection Investigator's van and equipment					33,000
					2,889,800

TABLE A-5. INITIAL CAPITAL COST SUMMARY, SEVEN COUNTY OPTION

Category	Item	Item Cost ($)	Category cost ($)
Building investment	Construction	4,069,000	
			4,069,000
Land investment	Purchase	1,197,239	
	Paving	182,336	
	Landscaping	105,785	
			1,485,360
Equipment investment	Facility equipment	2,427,500	
	Calibration vans	132,000	
	Central computer	250,000	
	Security systems	14,300	
	Quality Assurance van	33,000	
	Consumer Protection van	33,000	
			2,889,800
			8,444,160

One-Time Startup Costs

Costs in this category are for noncapital items and services on a one-time basis prior to startup. Considerations used in developing cost estimates for each element are discussed in Section 7.

Land Aquisition--

Costs for identifying and locating candidate sites, negotiating purchase price, and completing title transfers were defined as \$6,000/facility plus 10 percent of the unimproved land value. No difference is anticipated between the state-owned and contractor-owned options.

For the network described previously, a total of 10 sites are required, reflecting a total unimproved land investment of \$1,197,239. The cost for land acquisition, then, is calculated below:

$$\begin{aligned}&(10\text{ facilities})(\$6{,}000/\text{facility}) + (0.10)(\$1{,}197{,}239)\\ &= (\$60{,}000 + \$119{,}724)\\ &= \$179{,}724.\end{aligned}$$

Facilities Planning--

Costs associated with engineering and design for the test facilities, bid review, and construction monitoring were defined previously as 15 percent of the construction cost for the contractor-run option and 20 percent for the state-run option. The total construction cost was previously defined as \$4,069,000, the cost for facilities planning, then, can be calculated as follows:

State-run $(0.20)(\$4{,}069{,}000) = \$813{,}800$

Contractor-run $(0.15)(\$4{,}069{,}000) = \$610{,}350$

Program Design--

Costs for developing additional planning studies required to establish specific formats for operation and administration of both the actual inspection program and adjunctive programs such as public information, mechanics training, etc. were previously defined as approximately \$100,000 for both the state-run and contractor-run alternatives.

Data Handling Software Development--

Costs for development of a comprehensive data handing software package were previously defined as \$200,000 for both the state-run and contractor-run alternatives.

Personnel Training--

Cost estimates for training managers and assistant managers were defined, in Section 7, as \$53,00 each, while the costs for training inspectors and calibration persons were found to be \$16.00.

Applying per facility personnel requirements previously derived to the seven county network results in the following personnel numbers:

- 10 managers
- 10 assistant managers
- 105 inspectors
- 4 maintenance/calibration persons

Using these personnel requirements, and training costs derived previously, the cost of training operating personnel can be computed as:

(10 managers)($53.00) + (10 assistant managers)($53.00)
+ (105 inspectors)($16.00) + (4 maintenance/calibration persons)($16.00)
= $2,804.00

In addition, the state will have two investigators who will require training. A cost of $59.00 was derived for investigator training, this translates to $118.00 for training the two investigators.

The total cost, then, is the sum of the cost of training operating personnel plus the cost of training investigators, or:

$2,804.00 + $118.00 = $2,922.00

Personnel Salaries--
Personnel salaries and phase in schedules were defined previously in Section 7. Applying these schedules to the personnel requirements for this option, a total operating personnel cost estimate for startup can be derived:

[(10 managers)($1,667.00 per moth)(6 months)
+ (10 assistant managers)($1,125 per month)(6 months)
+ (4 maintenance/calibration persons)($1,000 per month)(1 month)
+ (105 inspectors)($867.00 per month)(1 month)] [1.25]
= $328,194

The administrative personnel costs for the startup period were defined previously in Section 7. These costs are provided in Tables A-6 and A-7 for the state-run and contractor-run options respectively. The total cost for startup, then, is the sum of the cost for operating personnel plus administrative personnel, or:

State-run $328,194 to $230,834 = $559,028

Contractor-run $328,194 to $175,418 = $503,612

TABLE A-6. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP, STATE-RUN OPTION

Job title	Number of positions	Annual salary ($)	Participation (months)	Salary startup period ($)*
Administrator	1	25,000	24	50,000
Training officer	1	13,000	12	13,000
Legal advisor	1	15,000	6	7,500
Engineering coordinator	1	15,000	18	22,500
Systems engineer/analyst	1	11,000	1	917
Financal coordinator	1	15,000	24	30,000
Accountant	1	12,000	6	6,000
Consumer protection investigator	1	15,000	1	1,250
Quality assurance investigator	1	15,000	2	2,500
Consumer protection/quality assurance supervisor	1	15,000	12	15,000
Clerical support	2	9,000	24/each	36,000
Total salaries for 24 months				184,667
Overhead @ 25 percent				46,167
Totals	12			230,834

*Salary for participation during 24-month startup period (all positions).

TABLE A-7. ADMINISTRATIVE PERSONNEL COSTS ASSOCIATED WITH PROGRAM STARTUP, CONTRACTOR-RUN OPTIONS

Job title	Number of positions	Annual salary ($)	Participation (months)	Salary startup period ($)[a]
Administrator	1	25,000	12	25,000
Training officer	1	13,000	6	6,500
Legal advisor	1	15,000	4	5,000
Engineering coordinator	1	15,000	6	7,500
Systems engineer analyst	1	11,000	1	917
Financial coordinator	1	15,000	6	7,500
Consumer protection	1	15,000	1	1,250
Quality assurance investigators	1	15,000	2	2,500
Consumer protection/qualtiy assurance supervisor	1	15,000	6	7,500
Clerical	1	9,000	12	9,000
Total salaries for state personnel				72,667
Overhead @ 25 percent				18,167
Total state cost				90,834
Contractor personnel:				
Administrator for station operations	1	25,000	12	25,000
Legal counsel	1	15,000	6	7,500
Purchasing/contracts officer	1	13,000	12	13,000
Engineer/analyst	1	11,000	12	11,000
Inspector training coordinator	1	13,000	2	2,167
Clerical	1	9,000	12	9,000
Total salaries for contractor personnel				67,667
Overhead @ 25 percent				16,917
Total contractor cost				84,584
			TOTAL COST =	175,418

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[a] Salary for participation during 12-month startup period.

Initial Public Information Program--

As discussed in Section 7, a preimplementation budget of $0.12/test to be performed has been suggested. The elimination of Brown and Dane counties from the program would reduce the inspectable fleet to 1.1 million vehicles, or 1,320,000 tests annually. This translates to an initial public information expenditure of $158,400.

Mechanics Training--

As discussed previously, in Sections 4 and 7, an estimate of the initial cost for a mechanics training program is $36,380.

A summary of anticipated startup costs is presented in Table A-8.

TABLE A-8. SUMMARY OF STARTUP COSTS, SEVEN COUNTY ALTERNATIVE

Item	State-run Option	Contractor-run Option
Land Acquisition	$ 179,724	$ 179,724
Facilities Planning	813,800	610,350
Program Design	100,000	100,000
Data Handling Software Development	200,000	200,000
Personnel Training	2,922	2,922
Personnel Salaries and Overhead	559,028	503,612
Public Information	158,400	158,400
Mechanic Training	36,380	36,380
	$2,050,254	$1,791,388

Annual Operating Costs

Annual operating costs include all costs associated with the actual operation of the program. For the purposes here, the costs of adjunctive programs (e.g., public information, inspection/mechanic training, etc.) are included under "Annual Administrative Costs", which are discussed later.

Facility Personnel--

Applying facility staffing requirements and annual salaries associated with job category, the annual operating personnel costs can easily to calculated. This estimate, shown in Table A-9, is assumed the same for either the contractor-run or the state-run options.

TABLE A-9. ANNUAL PERSONNEL COSTS FOR FACILITY PERSONNEL

Job Title	Total number of positions	Annual Salary ($)	Total annual salaries for all positions ($)
Manager	10	20,000	200,000
Assistant Manager	10	13,500	135,000
Calibration/Maintenance	4	12,000	48,000
Inspectors	105	10,400	1,092,000
Total salaries			1,475,000
Overhead at 25 percent			368,750
			1,843,750

Maintenance--

The yearly cost for equipment repair and preventive maintenance was previously defined as 20 percent of the original equipment cost, or:

$$(0.20)(\$2,427,500) = \$485,500$$

Utilities/Services/Supplies

Included in this element are the costs associated with electricity, heat, building services, insurance, computer operation, inspection forms, calibration costs, taxes and uniforms.

Utilities--

As previously defined, the electric usage requirements for loaded mode testing are 120 kWh/day for each lane, plus 325 kWh/day for each facility. Applying these rates and a $0.05/kWh cost provided by Wisconsin Power and Light to the seven county network, the annual cost then for utilities is:

$$\begin{aligned}&(35\text{ lanes})(120\text{ kWh/day})(\$0.05/\text{kWh})(250\text{ Operating day/yr})\\+\;&(10\text{ facilities})(325\text{ kWh/day})(\$0.05/\text{kWh})(250\text{ Operating day/yr}) = \$93,125\end{aligned}$$

Insurance--

An annual cost of $1,500/lane has been derived previously for liability, fire, theft, and vandalism insurance. This translates to $52,500 annually for insurance for 35 lanes.

Computer Operation--

A cost of $0.15/test was previously defined for computer operation costs. Given a seven county total of 1,320,000 tests annually, this translates to $198,000 annually.

Inspection Forms--

A cost of $0.03/test was previously derived for inspection forms. Given a seven county total of 1,320,000 tests annually, this translates to $39,600 annually.

Calibration Costs--

In Section 7, an annual cost of $11,000/calibration/maintenance person was computed for annual calibration costs. Applying this rate to the four persons required, this computes to $44,000 annually.

Taxes--

General property and real estate taxes must be included for a contractor-run option. Total annual taxes, itemized by municipality are provided in Table A-10.

Uniforms--

An annual cost of $125.00 was derived in Section 7 as a per employee cost for uniforms. This translates to $16,125 annually for 129 uniformed employees.

TABLE A-10. ANNUAL TAXES - CONTRACTOR-RUN OPTIONS

County	Municipality	Facilities/ lanes	General property value ($)	General property tax rate*	General property tax ($)	Real estate value ($)	Real estate* tax rate	Real estate tax ($)	Total taxes annually ($)
Brown	Green Bay	1/4	720,875	0.02758	19,882	187,120	0.02317	4,336	24,218
Dane	Madison	1/4	720,875	0.03174	22,881	214,412	0.02704	5,798	28,679
	Madison	1/3	564,125	0.03174	17,905	162,484	0.02704	4,394	22,299
Kenosha	Kenosha	1/3	564,125	0.02931	16,535	141,807	0.02556	3,625	20,160
Milwaukee	Milwaukee	2/6 ea.	2,117,750	0.04270	90,428	518,572	0.03592	18,627	109,055
	Greenfield	1/3	564,125	0.02974	16,777	128,022	0.02524	3,231	20,008
Ozaukee	Mequon	1/2	414,875	0.02557	10,608	45,908	0.02236	1,027	11,635
Racine	Racine	1/4	720,875	0.03322	23,947	100,693	0.02826	2,846	26,793
Walworth	Elkhorn	1/2	414,875	0.03045	12,633	49,294	0.02594	1,279	13,912
Washington	West Bend	1/2	414,875	0.02185	9,065	58,002	0.02012	1,167	10,232
Waukesha	Brookfield	1/4	720,875	0.02531	18,245	259,900	0.02216	5,759	24,004
	Waukesha	1/3	564,125	0.02412	13,607	183,162	0.02124	3,890	17,497
Additional Equipment			462,300	0.04270**	19,740	-	-	-	19,740
Total									273,036

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*Source: Town, Village, and City Taxes - 1976, Bulletin Nos. 176, 276 and 376 combined, Wisconsin Department of Revenue, Division of Research and Analysis, Bureau of Local Financial Assistance.

**Additional equipment assumed housed in Milwaukee.

The total cost for utilities, services, and supplies is provided in Table A-11 for both the state-run and contractor-run options.

TABLE A-11. ANNUAL COSTS FOR UTILITIES, SERVICES, AND SUPPLIES - STATE VERSUS CONTRACTOR-RUN OPTIONS, SEVEN COUNTY ALTERNATIVE

Item	State-run option cost ($)	Contractor-run option cost ($)
Utilities	$ 93,125	$ 93,125
Insurance	52,500	52,500
Computer Operation	198,000	198,000
Inspection Forms	39,600	39,600
Calibration Costs	44,000	44,000
Taxes	0 (exempt)	273,036
Uniforms	16,125	16,125
Total	$443,350	$716,386

Annual Administrative Costs

Costs involved in this category include salaries of personnel involved in areas such as enforcement, consumer protection, public information, training and overall program administration. Also, the cost for the public information program, and operating costs for investigators' vehicles are included in this category.

Program Administrative Salaries and Overhead--

Annual administrative personnel costs will not vary between the nine county option presented in Section 7 and the seven county option presented here. These costs are:

State-run	$180,000
Contractor-run	$208,125

Vehicle Operating Costs--

As previously derived, the state will have two vehicles for mobile investigators. Assuming an operating cost of $0.15/vehicle and annual travel of 12,000 miles, the annual cost of vehicle operation may be calculated as:

(2 vehicles)(12,000 miles/yr)($0.15 per mile) = $3,600

Public Information--

A cost of $0.12/test was defined as a reasonable estimate of annual public information costs. Applying this rate to an average annual number of 1,320,000 vehicles; this equates to $158,400 annually for public information.

Personnel Training--

A replacement rate of 10 percent of the inspector work force was defined previously in Section 7. This translates to 13 new inspectors/year for the seven county option. The cost of training a new inspector was previously found to be $16.00, therefore the entire cost is:

(13 persons)($16.00/person) = $208.00

Summary

The total cost for both the state-run and the contractor-run options are itemized in Tables A-12 and A-13, respectively.

FEE COMPUTATION

Annualized Costs

In order to compare costs of the two seven county options with those of the two nine county options and to devise a "breakeven fee", all costs from Tables A-12 and A-13 are converted into annual figures using the same methodology as was presented in Section 7.

Annualized costs for both seven county options are presented in Tables A-14 and A-15 in constant 1978 dollars and actual (inflated) dollars, respectively.

Fee Calculation

Breakeven fees were calculated for both options in constant and actual dollars. These fees are calculated by dividing the total annualized cost by the total average number of vehicle registrations (expected to be 1.1 million). These fees, which reflect one free retest for failed vehicles, are presented in Table A-16.

Cost Schedule

From the implementation schedule derived in Section 8, cost schedules were defined for both the state-run and contractor-run options, these schedules are provided in Tables A-17 and A-18, respectively.

TABLE A-12. COST SUMMARY - STATE-RUN OPTION

Primary category	Principal element	Element cost ($)	Total category cost ($)
I. Initial capital costs	1. Building investments	4,069,000	
	2. Land investments	1,485,360	
	3. Equipment costs	2,889,800	
			8,444,160
II. One-time startup costs	1. Land Acquisition	179,724	
	2. Facilities planning	813,800	
	3. Program design	100,000	
	4. Software development	200,000	
	5. Personnel training	2,922	
	6. Personnel salaries and overhead	559,028	
	7. Public information	158,400	
	8. Mechanics training	36,380	
			2,050,254
III. Annual operating costs	1. Personnel	1,843,750	
	2. Maintenance	485,500	
	3. Utilities/services/supplies	443,350	
			2,772,600
IV. Annual administrative costs	1. Personnel	180,000	
	2. Vehicle operation	3,600	
	3. Public information	158,400	
	4, New personnel training	208	
			342,208

TABLE A-13. COST SUMMARY - CONTRACTOR-RUN OPTION

Primary category	Principal element	Element cost ($)	Total category cost ($)
I. Initial capital costs	1. Building investments	4,069,000	
	2. Land investments	1,485,360	
	3. Equipment costs	2,889,800	
			8,444,160
II. One-time startup costs	1. Land acquisition	179,724	
	2. Facilities planning	610,350	
	3. Program design	100,000	
	4. Software development	200,000	
	5. Personnel training	2,922	
	6. Personnel salaries and overhead	503,612	
	7. Public information	158,400	
	8. Mechanics training	36,380	
			1,791,388
III. Annual operating costs	1. Personnel	1,843,750	
	2. Maintenance	485,500	
	3. Utilities/services/supplies	716,386	
			3,045,636
IV. Annual administrative costs	1. Personnel	208,125	
	2. Vehicle operation	3,600	
	3. Public information	158,400	
	4. New personnel training	208	
			370,333

TABLE A-14. ANNUALIZED COSTS IN CONSTANT 1978 DOLLARS

Cost Category	Cost ($)	Amortization factor (i = 0.06)	Annualized cost ($) (column 2 × column 3)
State-run option			
I. Capital costs			
1. Land	1,485,360	0.0600	89,122
2. Buildings	4,069,000	0.0870	354,003
3. Equipment	2,889,800	0.2374	686,039
II. Startup costs	2,050,254	0.2374	484,730
III. Operating costs	2,772,600	1.0	2,772,600
IV. Administrative costs	342,208	1.0	342,208
Total, State-run option			4,730,702
Contractor-run option			
I. Capital costs			
1. Land	1,485,360	0.0600	89,122
2. Buildings	4,069,000	0.0870	354,003
3. Equipment	2,889,800	0.2374	686,039
II. Startup costs	1,791,388	0.2374	454,276
III. Operating costs	3,045,636	1.0	3,045,636
IV. Administrative costs	370,333	1.0	370,333
			4,970,409

TABLE A-15. ANNUALIZED COSTS IN ACTUAL (INFLATED) DOLLARS

Cost category	Cost ($)	Amortization factor (i = 0.06)	Annualized cost ($) (column 2 × column 3)
State-run option			
I. Capital costs			
1. Land	1,485,360	0.1300	193,097
2. Buildings	4,069,000	0.1420	577,798
3. Equipment	2,889,800	0.2840	820,703
II. Startup costs	2,050,254	0.2840	582,272
III. Operating costs	2,772,600	1.210	3,354,846
IV. Administrative costs	342,208	1.210	414,072
Total, State-run option			5,942,788
Contractor-run option			
I. Capital costs			
1. Land	1,485,360	0.1300	193,097
2. Buildings	4,069,000	0.1420	577,798
3. Equipment	2,889,800	0.2840	820,703
II. Startup costs	1,791,388	0.2840	508,754
III. Operating costs	3,045,636	1.210	3,685,220
IV. Administrative costs	370,333	1.210	448,103
Total, Contractor-run option			6,233,675

TABLE A-16. BREAKEVEN FEES, f_c IN CONSTANT 1978 DOLLARS, AND FEE IN ACTUAL DOLLARS FOR THE STATE-RUN AND CONTRACTOR-RUN OPTIONS; SEVEN COUNTY ALTERNATIVE

Option	Fee in constant 1978 dollars	Fee in actual (inflated) dollars
State-run	4.30	5.40
Contractor-run	4.52	5.67

TABLE A-17. COST SCHEDULE FOR A STATE-RUN PROGRAM, 1979 THROUGH 1987

Year	Cost category				Accumulative total costs ($)	Accumulative* total revenues ($)	Surplus/ deficit
	Capital ($)	Startup ($)	Annual operating ($)	Administrative ($)			
1979	0	512,654	0	0	512,654	0	
1980	8,444,160	1,024,946	0	0	9,981,760	0	
1981	0	512,654	1,386,300	171,104	12,051,818	2,750,000	-9,301,818
1982	0	0	2,772,600	342,208	15,166,626	8,250,000	-6,916,626
1983	0	0	2,772,600	342,208	18,281,434	13,750,000	-4,531,434
1984	0	0	2,772,600	342,208	21,396,242	19,250,000	-2,146,242
1985	0	0	2,772,600	342,208	24,511,050	24,750,000	+ 238,950
1986	0	0	2,772,600	342,208	27,625,858	30,250,000	+2,624,142
1987	0	0	2,772,600	342,208	30,740,666	35,750,000	+5,009,334
Total	8,444,160	2,050,254	18,021,900	2,224,352	30,740,666	35,750,000	+5,009,334

*Assumes a $5.00 fee. All figures in constant 1978 dollars.

TABLE A-18. COST SCHEDULE FOR A CONTRACTOR-RUN PROGRAM, 1979 THROUGH 1987

Year	Cost category				Accumulative total costs ($)	Accumulative total revenues ($)	Surplus/ deficit
	Capital ($)	Startup ($)	Annual operations ($)	Administrative ($)			
1979	5,554,360	0	0	0	5,554,360	0	- 5,554,360
1980	2,889,800	1,791,388	0	0	10,235,548	0	-10,235,548
1981	0	0	3,045,636	370,333	13,651,517	5,500,000	- 8,151,517
1982	0	0	3,045,636	370,333	17,067,486	11,000,000	- 6,067,486
1983	0	0	3,045,636	370,333	20,483,455	16,500,000	- 3,983,455
1984	0	0	3,045,636	370,333	23,899,424	22,000,000	- 1,899,424
1985	0	0	3,045,636	370,333	27,315,393	27,500,000	+ 184,607
1986	0	0	3,045,636	370,333	30,731,362	33,000,000	+ 2,268,638
1987	0	0	3,045,636	370,333	34,147,331	38,500,000	+ 4,352,669
Total	8,444,160	1,791,388	21,319,452	2,592,331	34,147,331	38,500,000	+ 4,352,669

EMISSIONS

Two separate analyses were performed to determine the impact of varying two program variables — stringency factor and vehicle exemptions — on total emissions reductions within the nine-county area being considered. The results of these analyses are described here.

Varying Stringency Factors

The emission reduction computations described previously were repeated using stringency factors of 10 through 40 percent, in increments of 10 percent. The reductions as a percentage of first, emissions produced from the light-duty truck and car population, and second, emissions produced by the entire highway vehicle population, are shown in Table A-19, below, for CO and HC.

TABLE A-19. EFFECT OF VARYING STRINGENCY FACTOR ON CO AND HC EMISSIONS — PRESENTED AS PERCENT EMISSIONS REDUCTION AS A FUNCTION OF STRINGENCY FACTOR

Pollutant	Vehicles considered	Stringency factor			
		10%	20%	30%	40%
CO	LDV and LDT only	43	50	55	57
	All highway vehicles	29	35	38	40
HC	LDV and LDT only	37	42	46	48
	All highway vehicles	32	36	38	40

It is quite clear from the table above that the benefits associated with increasing stringency diminish at a rather rapid rate, especially when the stringency factor exceeds 20 percent. It can also be seen that the criterion established by EPA for minimum reduction of 25 percent in the emissions from the affected vehicles by 1987, would be met with a stringency factor even as low as 10 percent.

Varying Vehicle Exemption Criteria

The emissions reductions shown above (and throughout the report) reflect an inspectable vehicle population that consists of most passenger cars and light trucks that are not older than 15 years. However, it may be of interest to determine the emissions reductions achievable with a lower age exemption. For this analysis vehicles older than 10 years were excluded from the inspectable population and the emissions were computed for both CO and HC for 1987, for various stringency levels, as before. The results are shown in Table A-20.

TABLE A-20. EFFECT OF VARYING THE VEHICLE AGE EXEMPTION ON EMISSIONS REDUCTIONS FOR 1987

Pollutant	Vehicle categories	Percent reduction by stringency factor			
		10%	20%	30%	40%
CO	LDV and LDT only	37	43	47	51
	All highway vehicles	26	30	32	34
HC	LDV and LDT only	35	39	41	42
	All highway vehicles	30	33	35	36

Again, the scenario that would affect the fewest vehicles — that is a 10 percent stringency factor and an age exemption for vehicles older than 10 years — would still meet the EPA minimum reduction criterion.

APPENDIX B

DETAILED DESCRIPTION OF METHODOLOGY FOR CALCULATING EMISSION INVENTORIES

Emission inventories were calculated using the Mobile I computer program. The Mobile I routine is based upon vehicle-specific emission factors for vehicles operating through the EPA's Federal Test Procedure (FTP) urban driving cycle. The program, thus, contains tables of emission levels for each model year vehicle from 1950 to 1990 for various vehicle ages between 0 and 20 years old. Separate tables are used for light-duty vehicle (LDV), light-duty truck 1 (under 6,000 lb gross) LDT-1, light-duty truck 2 (between 6,000 lb and 8,500 lb gross) LDT-2, heavy duty diesel, and heavy duty gasoline. Separate tables are also given for three geographic regions: California, high altitude areas, and the rest of the country. The latter tables are used for Wisconsin.

Since the basic emission factors are FTP specific, factors must be adjusted to reflect driving patterns in local areas. Mobile I contains correction factors for temperature, speed, hot/cold/stabilized travel, air conditioning, vehicle load, trailer towing, and humidity. Due to lack of reliable data for Wisconsin, default values (FTP-specific conditions) are used for air conditioning, vehicle load, and trailer towing. Humidity affects nitrogen oxide only and, thus, is irrelevant for our applications. Hot/cold/stabilized VMT is assumed to be the same as national averages: 21 percent/27 percent/52 percent. Temperature is taken at 75ºF - this represents a typical July day when vehicle emissions are most acute.

The most important correction factor is vehicle speed. Emissions are not linear with respect to speed. So, whenever possible, speed classes must be differentiated. For all counties except Brown and Dane, speed classes are created by dividing travel between freeways, arterials, and local roads.

For a particular year, say 1987, the above factors give emissions per mile traveled for vehicles of various ages. To get aggregate per mile emissions for 1987, the emission factors for the various aged vehicles are weighted by the travel proportion for vehicles of that age (e.g., see the last column of Table B-1). The data used in calculating travel proportions, the distribution of vehicle ages and the travel of vehicles by age, are national averages contained in Mobile I. A Wisconsin vehicle age distribution for a particular year is inappropriate since it would reflect low sales in periods of recession and these cyclic fluctuations would be projected into the future periods.

To get aggregate emissions per mile for a particular county or region, values must be combined across the various speed classes (freeways, arterials, local roads). This is achieved by taking weighted averages using vehicle

TABLE B-1. TRAVEL WEIGHTING FACTOR CALCULATION LIGHT-DUTY VEHICLES

Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a)*(b)	((a)*(b)/sum) Travel fraction
1	0.075	15,900	1,192.5	0.106
2	0.107	15,000	1,605.0	0.142
3	0.107	14,000	1,498.0	0.133
4	0.106	13,100	1,388.6	0.123
5	0.100	12,200	1,220.0	0.108
6	0.092	11,300	1,039.6	0.092
7	0.085	10,300	875.5	0.077
8	0.077	9,400	723.8	0.064
9	0.066	8,500	561.0	0.050
10	0.052	7,600	395.2	0.035
11	0.039	6,700	261.3	0.023
12	0.027	6,600	178.2	0.016
13	0.018	6,200	111.6	0.010
14	0.014	5,900	82.6	0.007
15	0.009	5,500	49.5	0.004
16	0.006	5,100	30.6	0.003
17	0.005	5,000	25.0	0.002
18	0.005	4,700	23.5	0.002
19	0.005	4,400	22.0	0.002
20	0.004	4,400	17.6	0.002
		Sum:	11,301.0	

miles traveled (VMT) for the weighting fractions. To calculate total daily emission levels, emissions per mile are multiplied by VMT. The raw VMT and speed data used in this study are given in Table B-2 and Table B-3. These data are interpolated to the analysis years of 1977 and 1987 and are given in Table B-4 and Table B-5.

To calculate the effect of an I/M program on emissions, EPA derived - Appendix N, credits (percent reductions) are applied to emission factors. I/M credits are given for carbon monoxide and hydrocarbons, various technologies of vehicles (technology 1 vehicles built prior to 1975, technology 2 vehicles built from 1975 to 1979, technology 3 vehicles built in 1980 and technology 4 vehicles built after 1980) with and without mandatory maintenance, with stringency levels of 10, 20, 30, 40 and 50 percent, and for the number of years I/M has been in effect. In this study, I/M included mandatory maintenance, was at a stringency level of 20 percent, and had been in effect for 5 years (from 1982 to 1987). These I/M credits are also specific to vehicle type. These credits differ substantially from those found in the May 1977 version of Appendix N. Current I/M credits apply to light-duty vehicles and light-duty trucks.

TABLE B-2. DAILY VMT FOR BROWN AND DANE COUNTIES

Brown County - VMT analysis is for an area which is 85.4 percent of the county population. VMT is approximately 10 percent low since some local streets are omitted.

1974	1,441,506
2000	3,081,910

Average speeds are:

1974	31.6 mph
2000	23.0 mph

Vehicle types are

Auto	85.0%
Light truck	10.3%
Heavy truck (gas)	3.2%
Heavy truck (diesel)	1.5%

Dane County - VMT analysis is for an area which is 72.8 percent of the county population. VMT is approximately 10 percent low since some local streets are omitted.

1970	2,725,797
2000	4,278,454

Average speeds are

1970	32.4 mph
2000	30.9 mph

Vehicle types are

Auto	85.0%
Light trucks	8.5%
Heavy trucks (gas)	4.0%
Heavy trucks (diesel)	2.5%

Source: Wisconsin Department of Transportation
Madison, Wisconsin.

TABLE B-3. DAILY VMT AND AVERAGE SPEED

	1972					1985					2000				
	LDV	LDT	HDG	HDD	Average speed (mph)	LDV	LDT	HDG	HDD	Average speed (mph)	LDV	LDT	HDG	HDD	Average speed (mph)
Kenosha Co.															
Freeways	304,200	4,900	4,000	68,600	65.0	368,000	22,000	3,200	68,00	53.9	732,400	41,300	9,400	97,400	53.4
Arterials	895,300	72,000	53,400	25,300	32.6	1,423,800	128,500	53,100	26,300	35.1	1,706,200	102,000	109,100	30,600	36.1
Milwaukee Co.															
Freeways	3,404,300	201,900	238,300	132,500	48.5	4,441,200	270,500	267,800	154,900	41.2	5,073,200	328,600	296,000	196,200	47.0
Arterials	6,078,700	308,100	321,400	9,800	24.5	5,525,200	374,100	329,600	23,000	25.1	5,704,200	375,800	375,300	21,400	24.0
Ozaukee Co.															
Freeways	182,000	11,300	7,600	22,100	62.9	444,500	34,200	9,100	62,000	54.2	549,300	34,500	19,300	78,700	54.3
Arterials	521,500	34,100	32,400	39,000	38.6	612,700	40,700	32,600	4,200	36.3	749,400	39,000	43,700	5,000	36.4
Racine Co.															
Freeways	324,100	11,600	15,600	63,700	64.5	550,700	27,300	13,900	69,900	54.2	1,022,400	43,600	20,000	91,200	53.6
Arterials	1,204,200	110,200	75,500	8,100	29.6	1,568,100	141,500	76,800	11,900	33.2	1,654,300	92,300	142,500	14,300	34.0
Walworth Co.															
Freeways	147,700	8,900	4,600	4,000	64.6	322,500	32,900	12,300	36,000	53.6	964,200	100,400	22,100	149,800	52.8
Arterials	621,200	76,300	68,300	51,200	39.7	826,800	105,700	61,500	41,500	40.6	992,000	100,600	82,400	39,200	41.5
Washington Co.															
Freeways	166,800	9,600	5,700	7,900	65.0	351,600	39,800	7,900	43,200	53.2	691,100	52,200	37,300	71,700	53.0
Arterials	786,200	82,300	56,200	36,300	43.3	826,700	118,500	58,200	22,800	38.2	948,700	71,700	104,300	22,500	38.2
Waukesha Co.															
Freeways	814,000	47,900	56,100	51,100	60.8	1,474,200	117,600	72,500	66,300	53.1	1,591,800	118,500	99,100	76,100	54.6
Arterials	1,926,700	179,900	199,500	37,900	36.2	2,558,100	275,900	211,600	31,300	35.9	3,362,600	281,400	321,200	31,600	35.9
7 Counties Local/ Collectors	2,017,700	151,800	148,700	135,700	20.0	2,092,800	157,200	122,900	9,900	20.0	2,381,300	179,400	136,600	10,200	20.0

Source: **SEWRPC, Milwaukee, WI**

TABLE B-4. WISCONSIN VMT 1977

	Σ VMT (000)	% LDV	% LDT 1	% LDT 2	% HDG	% HDD	Average speed (mph)
Kenosha Co.							
Freeway	412.4	79.7	1.7	1.1	0.9	16.6	60.7
Arterial	1,271.3	86.4	4.4	3.0	4.2	2.0	33.6
Milwaukee Co.							
Freeway	4,422.1	86.0	3.1	2.1	5.6	3.2	45.7
Arterial	6,538.8	89.7	3.1	2.0	5.0	0.2	24.7
Ozaukee Co.							
Freeway	348.7	81.2	3.5	2.3	2.4	10.7	59.5
Arterial	651.3	85.5	3.4	2.2	5.0	3.9	37.7
Racine Co.							
Freeway	509.9	80.7	2.1	1.4	2.9	13.0	60.5
Arterial	1,552.0	86.6	4.7	3.2	4.9	0.6	31.0
Walworth Co.							
Freeway	189.7	77.9	5.7	3.8	4.0	8.6	60.3
Arterial	901.1	77.7	5.8	3.9	7.3	5.3	40.0
Washington Co.							
Freeway	287.0	82.9	4.4	3.0	2.3	7.5	60.4
Arterial	986.1	81.3	5.9	3.9	5.8	3.2	41.3
Waukesha Co.							
Freeway	1,262.6	84.6	3.5	2.4	4.9	4.5	57.8
Arterial	2,626.0	82.6	5.0	3.3	7.8	1.3	36.1
7 County							
Local	2,426.5	84.3	3.8	2.5	5.7	3.6	20.0

All data is derived directly from Table A-3 by linear interpolation.

Light-duty trucks are divided into LDT 1 and LDT 2 in proportions of 0.6 and 0.4.

TABLE B-5. WISCONSIN VMT 1987

	Σ VMT (000)	% LDV	% LDT 1	% LDT 2	% HDG	% HDD	Average speed (mph)
Kenosha Co.							
Freeway	521	79.8	2.9	1.9	0.7	14.8	53.9
Arterial	1,674	87.2	4.7	3.2	3.3	1.6	35.1
Milwaukee Co.							
Freeway	5,232	86.5	3.2	2.1	5.2	3.0	41.2
Arterial	6,277	88.4	3.6	2.4	5.3	0.4	25.1
Ozaukee Co.							
Freeway	567	80.8	3.7	2.5	1.7	11.3	54.2
Arterial	711	88.8	3.5	2.4	4.7	0.6	36.3
Racine Co.							
Freeway	737	83.2	2.5	1.6	2.1	10.6	54.2
Arterial	1,811	87.2	4.7	3.2	4.3	0.7	33.2
Walworth Co.							
Freeway	464	79.9	4.9	3.2	3.0	8.9	53.6
Arterial	1,063	79.8	6.1	4.1	5.9	4.0	40.6
Washington Co.							
Freeway	499	79.5	5.4	3.6	1.8	9.8	53.2
Arterial	1,047	80.6	6.9	4.6	5.7	2.2	38.2
Waukesha Co.							
Freeway	1,750	85.2	4.1	2.7	4.2	3.8	53.1
Arterial	3,706	83.1	5.4	3.6	6.9	1.0	35.9
7 County							
Local	2,382.8	87.8	4.0	2.6	5.2	0.4	20
Brown Co.							
All	2,912.6	85.0	8.7	1.6	3.2	1.5	27.3
Dane Co.							
All	5,451.1	85.0	6.8	1.7	4.0	2.5	31.6

All data is derived directly from Tables A-3 and A-4 by linear interpolation

Light duty trucks are divided into LDT 1 and LDT 2 in proportions of 0.6 and 0.4.

For Brown $\text{VMT} = (1.1)\dfrac{\text{Table (G) Value}}{0.854}$ For Dane $\text{VMT} = (1.1)\dfrac{\text{Table (G) Value}}{0.728}$

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2. U.S. Environmental Protection Agency. Appendix N - Emission Reduction Achievable Through Inspection and Maintenance of Light-Duty Vehicles, Motorcycles and Light- and Heavy-duty trucks. Proposed Rule. Federal Register 24(84):22177-22183. May 2, 1977.

APPENDIX C

ESTIMATED FUEL SAVINGS IN 1987 RESULTING FROM I/M

Fuel savings from the implementation of I/M in selected counties is calculated by determining program impact on the fuel consumption of LDTs and LDVs under 16 years old. Four factors are critical in deriving these figures. They are: (1) the stringency rate established, (2) average fleet fuel consumption rate (for LDV, LDT1 and LDT2) measured in miles per gallon, (3) total vehicle miles traveled (VMT), and (4) actual fuel economy improvement resulting from I/M.

The program will cover LDVs, LDT1s and LDT2s. Since vehicles in each of these categories exhibit different fuel consumption patterns, fuel savings are estimated separately for each of them.

The formula used to calculate fuel savings is:

$$\text{Gallons saved per year} = \frac{(\text{VMT})(\text{W})}{(\text{FM})} \times S \times F \times 322$$

where: VMT = daily vehicle miles traveled by the pertinent vehicle type in selected counties in 1987

W = weighting factor to determine how many VMT are generated by vehicles covered by the I/M program

FM = average fleet mileage for a fleet of a certain vehicle type in 1987

S = stringency rate

F = improvement in fuel economy realized by failed vehicles undergoing required maintenance

322 = factor to adjust daily VMT by yearly VMT

FUEL SAVINGS

LDV Fuel Savings

Table C-1 presents an estimate of the total VMT generated daily by LDVs in 1987. This figure must be adjusted to reflect VMT generated by LDVs less than 16 years old. Table C-2 calculates travel weighting fractions for LDVs by model year. These fractions are summed in Table C-3 resulting in W = 0.989.

Also, applying the weighting fractions to EPA mile per gallon figures by model year results in an average LDV fleet mileage figure of 24.622 miles per gallon.

TABLE C-1. ESTIMATED DAILY LDV VMT FIGURES FOR SELECTED COUNTIES FOR 1987

County	Daily vehicle miles traveled (in thousands)
Kenosha	2,195
Milwaukee	11,509
Ozaukee	1,278
Racine	2,548
Walworth	1,527
Washington	1,546
Waukesha	4,956
Brown	2,912.681
Dane	5,451.174
Local/collector*	2,382.8
Total	36,305.655

*This figure represents total local and collector roads VMTs for all the above counties except Brown and Dane.

SOURCE: SEWRPC, Milwaukee, Wisconsin

Table C-4 presents potential fuel savings based on a total LDV VMT figure of 36,305,655, a weighting factor of 0.989 and a fleet mileage rate of 25.622 mpg. A range of stringency rates is used to illustrate the sensitivity of fuel savings to this policy variable. A wide range of potential improvement in fuel economy realized by failed vehicles since the data on this factor has been inconclusive to date.

LDT 1 Fuel Savings

Table C-5 presents VMTs generated by LDTs in 1987. LDT1 generate 1,744,814 VMT. Table C-6 calculates travel weighting factors which are summed in Table B-7 resulting in W = 0.9545. Applying the travel weighting factors to estimated mile per gallon by model year figures results in an LDT1 fleet mileage figure of 20.571 mpg.

Table B-8 presents LDT1 fuel savings based on a 1987 VMT figure of 1,744,814 miles, a weighting factor of 0.953 and an average fleet mileage of 20.571 mpg. Again, several stringency rates and fuel economy improvement levels are analyzed.

TABLE C-2. TRAVEL WEIGHTING FACTOR CALCULATION FOR LIGHT-DUTY VEHICLES

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a) * (b)	[(a) * (b)/sum] travel fraction
1987	1	0.075	15900	1192.5	0.106
1986	2	0.107	15000	1605.0	0.142
1985	3	0.107	14000	1498.0	0.133
1984	4	0.106	13100	1388.6	0.123
1983	5	0.100	12200	1220.0	0.108
1982	6	0.092	11300	1039.6	0.092
1981	7	0.085	10300	875.5	0.077
1980	8	0.077	9400	723.8	0.064
1979	9	0.066	8500	561.0	0.050
1978	10	0.052	7600	395.2	0.035
1977	11	0.039	6700	261.3	0.023
1976	12	0.027	6600	178.2	0.015
1975	13	0.018	6200	111.6	0.010
1974	14	0.014	5900	82.6	0.007
1973	15	0.009	5500	49.5	0.004
Pre-1973	16+	0.025	23600	140.7	0.011

SOURCE: Mobile I, EPA; January 1978.

TABLE C-3. EPA MPG SPECIFICATIONS AND AVERAGE FLEET MILEAGE FOR LDVs COVERED BY I/M IN 1987

Year	EPA mileage standard	Travel fraction*	$\frac{\text{Column (2)} \times \text{column (3)}}{0.989}$
1987	27.5	0.106	2.948
1986	27.5	0.142	3.949
1985	27.5	0.133	3.698
1984	27	0.123	3.358
1983	26	0.108	2.839
1982	24	0.092	2.233
1981	22	0.077	1.713
1980	20	0.064	1.294
1979	19	0.050	.961
1978	18	0.035	.637
1977	17.5	0.023	.407
1976	16.8	0.015	.255
1975	16.0	0.010	.162
1974	15.5	0.007	.110
1973	15.0	0.004	.061
Totals		0.989	24.622

*From Table C-2

SOURCE: Federal Register, Book 1, Vol. 42, No. 126, p.33534, Thursday, June 30, 1977.

TABLE C-4. POTENTIAL ANNUAL LDV FUEL SAVINGS IN 1987 DUE TO I/M (IN GALLONS)

Increase in fuel economy realized by failed vehicles (%)	Stringency level (%)			
	10	20	30	40
2	939,146	1,878,292	2,817,438	3,756,584
3	1,408,719	2,817,438	4,226,157	5,634,876
4	1,878,292	3,756,584	5,634,876	7,513,168
5	2,347,865	4,695,730	7,043,595	9,391,460
6	2,817,438	5,634,876	8,452,314	11,269,752
7	3,287,011	6,574,022	9,861,033	13,148,044
8	3,756,584	7,513,168	11,269,752	15,026,336
9	4,226,157	8,452,314	12,678,471	16,904,628
10	4,695,730	9,391,460	14,087,190	18,782,920

TABLE C-5. ESTIMATED DAILY LDT VMT FIGURES FOR SELECTED COUNTIES FOR 1987

County	Daily vehicle miles travelled	
	LDT 1	LDT 2
Kenosha	93,671	63,391
Milwaukee	393,672	260,703
Ozaukee	45,829	31,215
Racine	103,439	69,680
Walworth	89,883	59,931
Washington	99,081	66,054
Waukesha	245,023	162,765
Brown	206,712	38,016
Dane	370,464	92,616
Local/Collector*	97,040	63,076
Total	1,744,814	907,447

*This figure represents total local and collector road LDT VMTs for all the above counties except Brown and Dane.

SOURCE: SEWRPC, Milwaukee, Wisconsin and GCA calculations.

TABLE C-6. TRAVEL WEIGHTING FACTOR CALCULATION LIGHT-DUTY GAS TRUCKS<6000 LBS (LDT 1)

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a) * (b)	(a) * (b)/sum Travel fraction
1987	1	0.061	15900	969.9	0.0927
1986	2	0.095	15000	1425.0	0.1362
1985	3	0.094	14000	1316.0	0.1258
1984	4	0.103	13100	1349.3	0.1290
1983	5	0.083	12200	1012.6	0.0968
1982	6	0.076	11300	858.8	0.0821
1981	7	0.076	10300	782.8	0.0748
1980	8	0.063	9400	592.2	0.0566
1979	9	0.054	8500	459.0	0.0439
1978	10	0.043	7600	326.8	0.0312
1977	11	0.036	6700	241.2	0.0231
1976	12	0.024	6600	158.4	0.0152
1975	13	0.030	6200	186.0	0.0178
1974	14	0.028	5900	165.2	0.0158
1973	15	0.026	5500	143.0	0.0137
pre-1973	16+	0.1	23600	476.0	0.047
			Sum =	10462.2	

SOURCE: Mobile I, EPA, January 1978.

TABLE C-7. MILEAGE ESTIMATES AND AVERAGE FLEET MILEAGE FOR LDT 1 COVERED BY I/M in 1987

Year	Estimated mileage[*]	Travel fraction[†]	$\frac{\text{Column (2)} \times \text{column (3)}}{0.953}$
1987	22.00	0.0927	2.140
1986	22.00	0.1362	3.144
1985	22.00	0.1258	2.904
1984	22.00	0.129	2.978
1983	21.84	0.097	2.223
1982	20.64	0.0821	1.778
1981	19.36	0.0748	1.520
1980	18.00	0.0566	1.069
1979	17.50	0.0439	0.806
1978	16.92	0.0312	0.554
1977	16.80	0.0231	0.407
1976	16.47	0.0152	0.263
1975	16.00	0.0178	0.299
1974	15.81	0.0158	0.262
1973	15.6	0.0137	0.224
Total		0.953	20.571

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[*] Based on limited LDT 1 mileage figures. More complete data may be available in the future.

[†] From Table C-6.

TABLE C-8. POTENTIAL ANNUAL LDT 1 FUEL SAVINGS IN 1987 DUE TO I/M (IN GALLONS)

Increase in fuel economy realized by failed vehicles (%)	Stringency level (%)			
	10	20	30	40
2	52,056	104,112	156,169	208,225
3	78,084	156,169	234,253	312,337
4	104,112	208,225	312,337	416,450
5	130,141	260,281	390,422	520,562
6	156,169	312,337	468,506	624,674
7	182,197	364,393	546,590	728,787
8	208,225	416,450	624,674	832,899
9	234,225	468,506	702,759	937,012
10	260,281	520,562	780,843	1,041,124

LDT 2 Fuel Savings

LDT 2 generated VMT in 1987 are estimated in Table C-5 to be 907,447. Table C-9 calculates travel weighting factors which are summed in Table C-10, resulting in W = 0.9302. Applying the travel weighting factors to estimated mile per gallon by model year figures results in an LDT fleet mileage figure of 17.588 mpg.

Table C-11 presents LDT 2 fuel savings based on a 1987 VMT figure of 907,447 miles, a weighting factor of 0.9304 and an average fleet mileage of 17.588 mpg.

SUMMARY FIGURES

Table C-12 presents combined fuel savings for all LDVs and LDTs covered by an I/M program in selected counties for the year 1987. As a best guess single estimate, 7,154,769 gallons will be saved if the stringency rate is 20 percent and failed vehicles undergoing repair experience a 7 percent improvement in fuel economy.

If fuel prices increase at 2 percent per year (a conservative estimate) and the current average price is $0.67 per gallon, a gallon of fuel will cost $0.80 in 1987. Thus, I/M can potentially save consumers $5,723,800 in fuel costs in 1987 alone. If 1,727,000 vehicles are covered by the program 518,100 will fail. These vehicles will realize the fuel economy improvement and hence receivi the monetary savings resulting from lower fuel consumption rates. The average failed vehivle will save 13.81 gallons of fuel or $11.05 in 1987.

TABLE C-9. TRAVEL WEIGHTING FACTOR CALCULATION LIGHT-DUTY GAS TRUCKS 6001 TO 8500 LB (LDT2)

Year	Vehicle age	(a) Fraction total registration	(b) Annual mileage accumulation rate	(a)&(b)	((a)&(b)/sum) travel fraction
1987	1	0.037	15,700	580.9	0.0614
1986	2	0.070	15,700	1099.0	0.1162
1985	3	0.078	14,100	1099.8	0.1162
1984	4	0.086	12,600	1083.6	0.1145
1983	5	0.075	11,300	847.5	0.0896
1982	6	0.075	10,200	765.0	0.0809
1981	7	0.075	9,400	705.0	0.0745
1980	8	0.068	8,600	584.8	0.0618
1979	9	0.059	8,000	472.0	0.0499
1978	10	0.053	7,500	397.5	0.0420
1977	11	0.044	7,100	312.4	0.0330
1976	12	0.032	6,600	211.2	0.0223
1975	13	0.038	6,300	239.4	0.0253
1974	14	0.036	6,000	216.0	0.0228
1973	15	0.034	5,500	187.0	0.0198
	16+	0.14	23,400	660.8	0.07
				Sum=9461.9	

Source: MOBILE1, EPA, January 1978.

TABLE C-10. MILEAGE ESTIMATES AND AVERAGE FLEET MILEAGE FOR LDT2s COVERED BY I/M IN 1987

Year	Estimated mileage*	Travel fraction†	Column (2)×column (3) 0.9302
1987	20.125	0.0614	1.328
1986	20.196	0.1162	2.523
1985	20.268	0.1162	2.532
1984	19.969	0.1145	2.458
1983	19.297	0.0896	1.859
1982	17.875	0.0809	1.555
1981	16.443	0.0745	1.317
1980	15.000	0.0618	0.997
1979	14.300	0.0499	0.767
1978	13.594	0.0420	0.614
1977	13.262	0.0330	0.470
1976	12.775	0.0223	0.306
1975	12.160	0.0253	0.331
1974	11.780	0.0228	0.289
1973	11.400	0.0198	0.243
		0.9302	17.588

*Based on limited LDT2 mileage figures. More complete data may become available in the future.

†From Table C-9.

TABLE C-11. POTENTIAL ANNUAL LDT2 FUEL SAVINGS IN 1987 DUE TO I/M, IN GALLONS

Increase in fuel economy realized by failed vehicle, %	Stringency level, %			
	10	20	30	40
2	30,908	61,815	92,723	123,631
3	46,362	92,723	139,085	185,446
4	61,815	123,631	185,446	247,262
5	77,269	154,539	231,808	309,077
6	92,723	185,446	278,170	370,893
7	108,177	216,354	324,531	432,708
8	123,631	247,262	370,893	494,524
9	139,085	278,170	417,254	556,339
10	154,539	309,077	463,616	618,154

TABLE C-12. POTENTIAL ANNUAL FUEL SAVINGS DUE TO I/M IN 1987, IN GALLONS

Increase in fuel economy realized by failed vehicles, %	Stringency rate, %			
	10	20	30	40
2	1,022,110	2,044,219	3,066,330	4,088,440
3	1,533,165	3,066,325	4,599,495	6,132,659
4	2,044,219	4,088,440	6,132,659	8,176,880
5	2,555,270	5,110,545	7,665,775	10,221,099
6	3,066,325	6,132,659	9,198,990	12,265,319
7	3,577,385	7,154,769	10,732,154	14,309,539
8	4,088,440	8,176,880	12,265,319	16,353,759
9	4,599,495	9,198,990	13,798,479	18,397,979
10	5,110,550	10,221,099	15,331,649	20,442,198

APPENDIX D

INTRODUCTION

Due to the harsh northern climate, some problems arise with respect to winter operation of centralized test facilities in Wisconsin. The average daily minimum temperature in Madison during the period from December to March, for example, is 16.5°F; and in addition, over 45 inches of snow accumulates there annually.[1] Unless properly planned for, facility operation under these conditions could cause equipment damages, inaccurate test results, and might even pose serious health and safety problems.

Several commonly experienced problems associated with winter operation of high volume emissions inspection facilities are presented here with possible mitigating measures to consider in dealing with these problems.

PROBLEMS ASSOCIATED WITH WINTER EMISSIONS TESTING

Low Temperatures

In 1974, a panel established by the National Academy of Sciences, Committee on Motor Vehicle Emissions reported that, "ambient temperature variations, commonly encountered in large sections of the nation during winter, can significantly increase exhaust emissions of hydrocarbons and carbonmonoxide above the emissions measured during the course of the CVS-CH(FTP) test."[2] The problem recognized here is that during initial startup, the engine requires the carburetor to provide a rich air:fuel mixture to assure a combustible mixture. This very rich mixture, as high as 1:1, is obtained by the engagement of a choke valve. During warmup, the engine still requires a rich mixture, but the degree of richness must be progressively reduced during the warmup period. Eventually, the engine runs satisfactorily with the normal steady-running fuel-air ratios.[3]

The initial stage of vehicle operation when engine and coolant temperatures have not stabilized is referred to as cold mode operation. With cooler temperatures, the length of the cold mode cycle increases; the additional period of time, however, is slight. After a vehicle has "soaked" overnight (8.5 hours) for example, it would be in cold mode operation for 6.7 minutes at 75°F while the same vehicle would be in cold mode operation for 7.0 minutes at 20°F.[4] This indicates that the percent of vehicles arriving at the inspection facility while operating in the cold mode would be greater in the winter, though very slightly. Cold mode operation is, however, characterized by very high emission rates of carbon monoxide and hydrocarbons relative to stabilized operation.[5]

Another problem concerning winter temperatures has to do with the steep temperature differential between ambient conditions within the test and the outside air. Even the more sophisticated emission analyzers, undergoing frequent quality control checks to minimize analyzer, sampling system, and calibration error, while performing vehicle replication tests, can show under varying ambient conditions total variability many times greater than the equipment test variability.[6] Frequent opening of inspection facility doors will result in temperature variations within the inspection lane over time. A common energy saving measure of lowering the thermostat at night might also result in problems, especially if the analyzer is only calibrated daily. Vehicles tested later in the day, when the lane has been heated up to more comfortable temperatures will receive erroneous results.

It is likely that at certain times, especially at the end of the month if inspector deadlines are set then, vehicles may encounter delays at the inspection facilities and thus be forced to idle for lengthy periods in the cold. The result of such a waiting period is a significant increase in tailpipe moisture. Again, if not properly planned for, this will effect test results. Moisture from the tailpipe can find its way into the sampling line and cause "hydrocarbon hangup" making erroneous not only that vehicle's test data, but altering subsequent samplings as well.

One obvious safety problem associated with cold weather operation is the possibility that in a test lane, when doors are closed, the ambient concentration of carbon monoxide could reach unsafe levels making working conditions dangerous.

Snow

Wisconsin, not unlike other northern states, will have to face additional winter operation challenges with respect to snow accumulations. The major impacts of snow-related problems concern safety, equipment damage, and consumer convenience.

Studded snow tires pose a serious problem when a loaded-mode test is employed. Most conventional dynamometers will be severly damaged by frequent use with studded tires, as the steel rollers will be worn out quickly by the friction caused by the metal studs. In addition, a stud could come loose while the wheels are spinning on the dynamometer and be projected at high speed in an unpredictable fashion posing a serious safety problem.

Another snow-related safety problem occurs when vehicles arrive at the test lane covered with snow. Melting snow will result in slippery, wet floors posing yet another threat to the safety of those in the lanes.

Snow can also pose a consumer convenience problem; motorists may encounter delays or even the cancellation of testing operations while queuing areas are plowed.

Seasonal Variations in Gasoline

The saturated compounds in gasoline from area refineries can vary by as much as 20 percent. Yet, the infrared analytical equipment commonly used in emissions testing responds disproportionately to the relatively unreactive saturated compounds and the reactive aromatics and olefins.[7] In addition, changing temperatures significantly effect the Reid Vapor Pressure (RVP) of gasoline seasonally.[8] These variables interacting with the temperature and humidity changes, has been shown, under some circumstances, to accentuate air/fuel mixture excursions well beyond normal. Taken collectively, testing errors can be highly significant when considering these field test variables.[9]

MITIGATING MEASURES

Impact of many of the problems discussed in Section 2 may be minimized through proper planning, test procedures, and equipment.

By employing the loaded-test mode, problems associated with cold mode operation may be minimized. Performing the high and low cruise components of the test before the idle portion serves as a preconditioning method to normalize engine temperatures and thus, the idle emission readings. Not only will this minimize winter problems of cold mode operation, it will achieve the same results when dealing with extremely hot summer temperatures as well.

Aside from reducing waiting times by the availability of additional lanes, one solution to the tailpipe moisture problems is to heat sample lines, thus minimizing hydrocarbon hangup problems.

To alleviate problems with temperature fluctuations, test facilities should be equipped with analyzers that are self-contained in well-insulated, heated/air-conditioned cabinets. During winter and summer months, the analyzers should be recalibrated every few hours.

To assure against unsafe carbon monoxide levels in the test lanes, fresh air circulatory systems should be utilized, and ambient CO monitors provided as warning devices.

In anticipation of possible snowplowing delays, registration expirations should be staggered in such a way that fewer vehicles would have to be tested during the winter. Extended hours of operation should be offered on days following snow delays.

Since vehicles registered in Wisconsin are currently prohibited from using studded snow tires, the associated safety and equipment problems will be avoided. Motorists should be advised, however, that chains must be removed before the vehicle can be tested. Should the state rescind prohibition of studded tires, dynamometers with specially treated rolls are capable of withstanding studded tires, but are, of course, more expensive.

To account for other seasonal variabilities in operating conditions and fuels, different standards or tolerances may be applied either seasonally or when adverse ambient conditions exist.

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